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THE WIDENING OF LONDON BRIDGE.*

By HAROLD J. SHEPSTONE.

AN interesting and at the same time difficult piece of engineering work now being carried out in London is the widening of London Bridge. For years it has been apparent to the authorities that this classic structure of Rennie is insufficiently wide for the heavy traffic it is called upon to carry. Indeed, for its size it is without question one of the busiest bridges in the world. On an average over 120,000 foot passengers and 25,000 vehicles cross it every twenty-four hours. True, a greater number of pedestrians as well as vehicles pass over Brooklyn Bridge in a like period, but it must be borne in mind that London Bridge is only 53½ feet wide between parapets, whereas its American rival has a breadth of 85 feet.

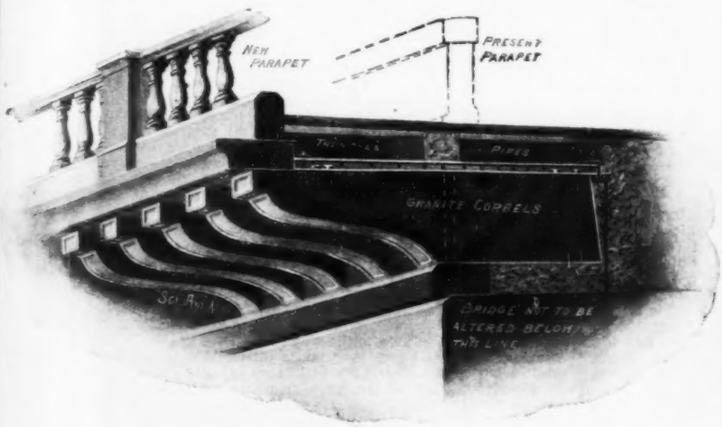
It was hoped when the Tower Bridge was erected, only a few hundred yards lower down the river, at a cost of over $5,000,000, that it would relieve the traffic of London Bridge; but, as in all great cities, to make a new bridge useful, new roads leading to it must be constructed, and these in turn call for new shops, railroad stations, theaters, places of business, exchanges or other creators of traffic. In the case of London Bridge, the pedestrian traffic is more inconvenienced than the vehicular traffic, chiefly because it is more difficult to marshal, and some three years ago the Bridge House Estates Committee of the Corporation of London decided to widen the footpaths.

The manner in which this work is being carried out is interesting on account of the stringent conditions under which the contractors have had to carry on their task. First of all, neither the pedestrian or vehicular traffic over the bridge, nor the traffic in the river, was to be interrupted. The committee further stated that in erecting temporary footbridges—which was a necessary feat seeing that the passenger traffic was not to be interrupted—"no scaffolding or staging in the line of the waterways or archways of London Bridge will at any time be permitted." It was also most essential that the finished structure should possess some architectural beauty. Two designs for widening the bridge were submitted to the committee, one by means of cast-iron cantilevers and balustrade, the other by adopting granite corbeling or cantilevers and an open granite balustrade. The granite scheme was decided upon, and in April, 1902, work was actively commenced.

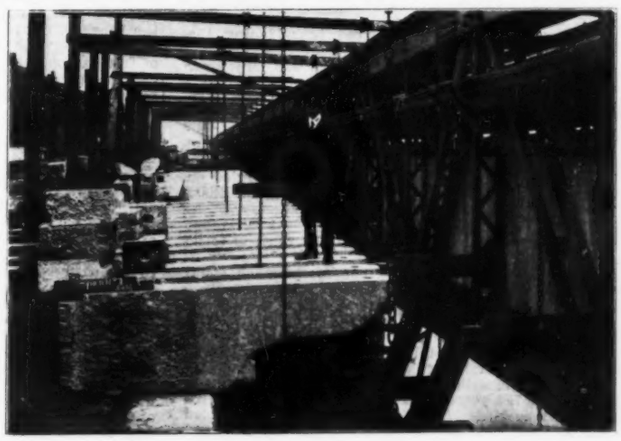
First of all, steel temporary footbridges were erected. They rest upon supports built up on the cantilevers of the piers of the main structure. There are two vertical

HOW THE CORBELS ARE BOLTED IN PLACE TO THE CHANNEL IRON ROD EXTENDING THE LENGTH OF THE BRIDGE.

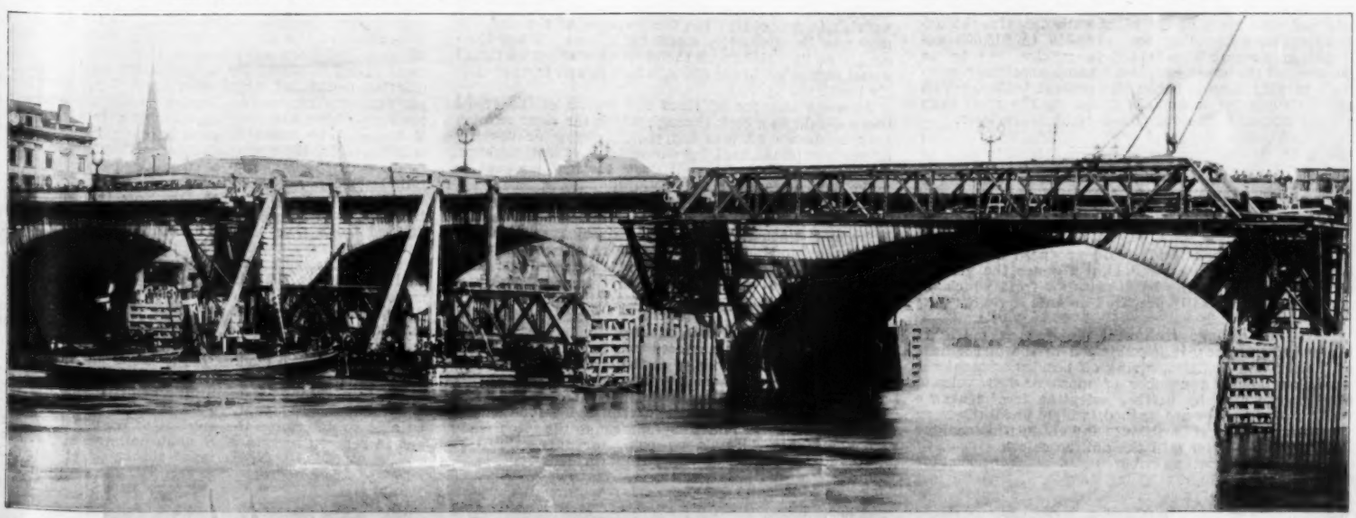
* Specially prepared for the SCIENTIFIC AMERICAN SUPPLEMENT.



THE SCHEME FOR WIDENING LONDON BRIDGE.



ANOTHER VIEW OF THE CORBELS.



LIFTING THE STEEL GIRDERS INTO PLACE FOR THE TEMPORARY FOOTWAYS.

steel pillars 25 feet high, with two corresponding inclined supports which rake from the top inward toward the bridge. These four columns, suitably joined together, form cantilevers, resting on the projecting stonework of the bridge piers; while steel shoes, bedded in the granite masonry by concrete, are placed to distribute the pressure due to the weight. These bridges are placed sufficiently far away from the main structure to permit of the widening, and are tied together by steel ties, 12 inches wide and 1 inch thick, which pass under the roadway. In this way one bridge supports the other. The ties, of course, are carried right through the bridge.

Each of the temporary bridges consists of five spans, one of which is 157 feet, 7 inches in length, the four others being 145 feet, 5 inches long. The erecting weight of the largest span was about 75 tons. The method of lifting them into position was as follows: The span was built up upon a large pontoon which was moored near the site, then towed by tugs to the bridge, placed in the right position, and lifted on to the cantilever piers by means of four vertical derricks. The time actually occupied in placing a span was from fifteen to twenty minutes. It was no easy task; the tide at this particular spot runs at the rate of about four knots per hour. Not only do these spans supply the temporary footpaths, but they also serve as a track for four electric jib traveling cranes, two on each track, used for the demolition of the old work and the erection of the granite corbels, parapet, etc. In order to shut off the working of the cranes from the pedestrians, a galvanized roof has been built over the temporary footpaths, thus making a covered gallery right across the bridge on each side. These covered crossings are 12 feet wide and 12 feet high. At night they are lit by electric light.

As soon as these footpaths were ready, the footways across the main structure were closed. These were originally each 9½ feet wide, but when the new scheme is completed they will each be 15 feet wide, making a total additional width to the bridge of 11 feet. As already stated, this is being obtained by building out from the main edifice granite corbels which will support the new footpaths. They will project from six to seven feet over the existing masonry. On the outer end of these corbels will be constructed an open granite balustrade. Some 650 corbels are required in all, and over 600 are already delivered ready for setting. They have a length of 10 feet, 6 inches, are 3 feet, 3 inches in height, and vary from 15 to 18 inches in thickness. They are each tested to a 4-ton load, and it is interesting to note that a pressure of from 50 to 60 tons applied at the outer end is required to break them. They are laid about 18 inches apart, and firmly bolted into position by lewis bolts attached to a channel iron running across the whole length of the bridge, the lewis bolts going down into the existing masonry for a depth of 3 feet. After the corbels comes the cornice, then the plinth, the balustrade, and coping. Some 1,600 balusters will be used in the work, each 2 feet, 4 inches high. The total height of the new parapet will be 4 feet, thus affording the pedestrians a clear view of the river and the shipping. It will give the bridge quite an artistic finish and will be an agreeable change from the closed parapet of the old design.

The granite that is being used in widening the bridge is being obtained from the same quarries that supplied the stone of which the bridge was built over seventy years ago. These are the famous Dartmoor quarries, which have been worked without any intermission for fully a century. For the past twenty-five years Messrs. Pethick Brothers, the well-known contractors of Plymouth, have held the lease of the land and have the right of quarrying over a thousand acres. The work of widening the bridge is being carried on for the City Corporation, Mr. E. Cruttwell, M. Inst., C. E., being engineer, and Mr. Andrew Murray, F. R. I. B. A., architect. The cost of the contract is put down as slightly over $500,000, and the work is to be completed by next spring.

Of London Bridge and its predecessors much could be written. For ages it was the only crossing place of the tidal waters of the Thames. The first wooden bridge, built in 1008, was destroyed by storm and flood in 1090, while in the reign of Stephen a second wooden bridge perished by fire. Then, in 1176, was begun the first stone bridge, its erection occupying a period of no less than thirty-three years. During its long life of 750 years it had many strange and weird associations. Heads of rebellious leaders were placed upon its gates. Once a fire broke out at one end, and when the bridge was swarming with spectators the flames were carried by the wind to the other end, so that the crowd was trapped and 3,000 were burned or drowned. As early as the eighteenth century, the authorities were spending from $10,000 to $15,000 annually in keeping the bridge in repairs, but to no purpose, as the structure had become absolutely ruinous. In 1823 Rennie began the present bridge, which was built one hundred yards higher up the river than the old one, and was completed eight years later.

COAL-TAR OILS IN THE MANUFACTURE OF PAINT AND VARNISH.

By DR. OSKAR MARKFELDT.

THAT thick black fetid liquid produced at the gas houses and coke ovens, and known under the generic term of coal-tar, is the basic material from which almost all the artificially prepared organic dyestuffs now in use are derived.

Placed in a huge iron still, holding as much as 25,000 kilogrammes, it is subjected to the *direct* heat of the fire and distilled, giving off besides ammoniacal water or liquor, a number of more or less volatile oils, from which by further scientific treatment the real raw materials are gained, which yield the very valuable and most brilliant and beautiful coal-tar dyestuffs, and better still the aniline colors.

By far the most valuable distillate from coal-tar is the so-called "light oil," meaning not heavy. From this, by means of a repeated distillation in smaller wrought-iron retorts holding from 2,000 to 2,500 liters, but in other respects the counterparts of the large stills, *benzol*, better known as *benzene*, is freed from the tarry substances that were carried over with it in the first distillation, by being subjected to the direct heat of the fire. Benzene thus obtained is far from pure; it still contains the similar though less volatile compounds *toluol* and *xylol*, besides several other bodies in smaller proportions; further, it contains also acid constituents (such as the phenols or carbolic acid and its homologues) and bases. To remove these, the benzene is subjected to a washing process by agitating it with soda-lye to dissolve out the *phenols*, which uniting with the sodium of the lye form a salt and pass over into the aqueous caustic soda solution. Having absorbed the *phenols*, and thereby becoming of a greater specific gravity, the soda-lye settles to the bottom of the vessel while the *benzene* floats. The two are now mechanically parted by drawing off the *benzene*, which is again washed with an inorganic acid; in most cases, sulphuric acid of 1.3 sp. gr. is used.

After strenuous stirring for about fifteen minutes, the mixture is allowed to stand for an hour or two. The precipitates which are the acids containing the bases, are now removed and subjected to the *pyridine* treatment.

There yet remain in the benzene certain so-called unsaturated compounds, such as hexene and its homologues, which must be dissolved out by the use of stronger sulphuric acid solutions. After this operation, and in order to dispose of the excess of acid particles, the emulsion is washed several times with water, very weak soda-lye, and again with water; and now for the third time the benzene is thrown into a retort with a steam jacket and redistilled.

Two grades of benzene are common in the trade; the so-called 90 per cent benzene, which represents a product of which 90 per cent of its volume can be distilled over at a temperature of 100 deg. C.; and a 50 per cent benzene, of which only half its volume can be driven over under the same conditions. The first of these grades, because it is the oftenest employed, claims our attention particularly, since only this grade is used in the manufacture of varnish, chiefly in the making of the cheap asphalt varnishes. These cheap varnishes are extensively consumed in the iron industries and form a very serviceable substitute for the much dearer asphalt varnish, made from natural asphalt dissolved in oil of turpentine. Though the manufacture of these cheap iron varnishes is *per se* a very simple process, yet there are moments in the operation when considerable care must be exercised. It is no secret that the base of these cheap varnishes is the so-called artificial asphalt, that is the pitch or residue obtained from the distillation of coal-tar, and the question arises just which sort of the pitch is best adapted for the purpose. The quality of the residual pitch depends primarily upon the quantity of the heavy oils still remaining in it after the distillation, so that the presence of a greater or less quantity of the oils results in a softer or harder grade of pitch; and the drying properties of varnish, as also its power of resisting mechanical influences or attrition after drying, are directly traceable to the plasticity of the pitch. A soft pitch contains considerable volumes of oils that boil at higher temperatures and which, combining with the benzene, retard the drying greatly. Very solid or hard pitch, on the other hand, contains large quantities of free carbon, which is not soluble in benzene; in this case more pitch is needed and a considerable residue results. A medium hard grade of pitch is therefore advisable.

Usually the making of the varnish itself is conducted in this wise: first melt the pitch in a kettle over an open or direct fire and add the desired weight of rosin or gum; when these are thoroughly melted and combined, draw the fire and allow the caldron to cool down a little, after which carefully run in the benzene, stirring the while. Disregarding the danger of fire that attends this operation, which should of course be intrusted to only tried and careful workmen, it seems to me that my method, which makes use of a steam jacketed kettle, produces a varnish of a superior quality. I proceed thus: In a kettle with a steam coil, or a steam jacket about it (this latter is better) placed high upon a work bench, I put 100 parts by weight of 90 per cent benzene and to this add 40 parts of coarsely-powdered rosin (colophonium), which, if continuously stirred, dissolves very quickly. To this add 90 parts of medium hard coal-tar pitch, also coarsely powdered, and with continued stirring warm the mass up to 50 deg. or 60 deg. C. After stirring from a half hour to an hour, and in order to prevent further distillation of the benzene, turn off the steam and run cold water through the jacket of the kettle until the heat of the varnish is reduced to the temperature of the day. It may now be allowed to stand for a time. When thoroughly settled, siphon off the clear varnish into a closed vessel somewhat lower down, where it will further clarify itself.

At some distance up from the bottom of the vessel there should be a cock through which the clear varnish may be drawn off into barrels. Little or no use has as yet been discovered for the residue, except, perhaps, the mixing of it with coal dust, sawdust, or peat to make briquettes.

Attending this process is only one disadvantageous circumstance, viz., the unavoidable boiling away of some of the benzene during the mixing, but if the operation be conducted in a closed receptacle provided with a mechanical stirring device, the distillate may be regained. A varnish made in this wise possesses good covering powers and a remarkable gloss, besides drying in a few minutes, a quality which is a matter of much importance to the consumer; moreover, it does not scale off smooth surfaces nor is it easily affected by atmospheric changes or conditions.

From its resemblance to glass and its remarkably glossy appearance, the pitch made from lignite—a sort of peat or bituminous carbonated wood—should be a supposedly good accompaniment to the pitch made from ordinary bituminous coal, for increasing the brilliancy and gloss of these iron varnishes. This is, however, not the case, as its presence is on the contrary a detriment, for it materially affects the drying qualities of the varnish and, if added in considerable quantities, will cause it to remain forever tacky. Benzene being an excellent solvent for caoutchouc, which is also used as an ingredient in the manufacture of certain kinds of varnishes, it may turn out that rubber will some day be advantageously used in the composition of these inferior varnishes. As a solvent for crude rubber benzene has come more and more into use in the rubber industries, especially since its price has, in the last few years, been reduced to about one-third of its former value. This great cutting down of the price has been brought about by the increased production of coke (used for smelting and reduction) and the resultant by-products, so that there is now no fear of benzene ever again reaching its former high-water mark. Of the other coal-tar oils, creosote and anthracene are perhaps of even greater importance than benzene, since they are consumed in large quantities in the manufacture of paints and stains for the coating and impregnating of wood instead of iron. In creosote by far the greatest quantity of naphthalene obtained from coal-tar is found; indeed it is present to such an extent that on cooling it begins to separate spontaneously, and, if permitted to remain for a time undisturbed, still more will crystallize out. Similarly, from the heavy anthracene oils, if allowed to stand a while, will appear a crystalline pulp, of which the principal component part is anthracene and which is in itself the basic material from which are won the alizarine dyes so widely distinguished for their brilliancy and fastness. Both these oils in time spontaneously separate from their semi-solid constituents and under the name *carbolineum* occur in commerce in varied mixtures as preservatives and coatings for wood. The brand known as "Avenarius Karbolineum" is the best, and it is said to be prepared under a patented process which treats the heavy coal-tar oils with chlorine. This brand is distinguished by its reddish brown color and is of the consistency of syrup; it also commands a much higher price in the open market than the ordinary compounds of *creosote* and *anthracene* oils. In use the difference is readily appreciated, for the commoner mixtures become of a smutty, blackish hue when drying into the wood, especially where creosote oil predominates, while a coating of Avenarius Karbolineum retains indefinitely a beautiful nut brown color. This lasting quality led experimenters to seek means of improving its color, deodorizing it if possible, and correcting its viscosity, or, in other words, making it thinner. According to Dr. H. Nördlinger, the quality of coal-tar oils which are destined for the impregnation of wood is greatly improved if treated with a 1 per cent or a 1½ per cent solution of a water-soluble copper salt, say copper-chloride, or by mixing their aqueous or alcoholic solutions and, after standing, drawing off the water stratum. Having determined upon an admixture, its treatment with the alcoholic or acetone solution of mercury, zinc, or cadmium-acetate, aluminium, zinc, or cadmium chloride, or zinc-protochloride will produce the same results as the copper salts. In the reddish brown color which makes its appearance almost immediately after applying to the wood, this carbolineum possesses its most attractive features for the buying public of to-day. Since these oils are required to sink deeply into the wood, they should not be thickened with any pigments, which would any way easily scale off after the coal-tar oils had left them on the surface, unless some of the binding material had been added. Just here comes in another of the numerous coal-tar products to help out the difficulty, the class of oil-soluble or fat-soluble *azo-dyes*. The greatest inconvenience in the use of the aniline colors arises from their tendency to fade under the action of light, but as the coating of tar oil even without any coloring matter turns brown with time, in this case the fading characteristic of the brown aniline improves, yes, completes the work. Indeed, in this manner a very durable covering for the wood is attained, while no impediment prevents the antiseptic oil from permeating the fiber and thoroughly staining it. Until recently carbolineum only existed in brown, but since the use of the azo dyes has become possible, it now appears in a variety of shades and one manufacturer puts up a brand which he facetiously dubs *Holz-doktor* (wood doctor). These various shades are of course similarly obtained by the use of the other oil-soluble aniline dyes.

From anthracene oil itself a brown dyestuff may be made, which will serve to color the carbolineum, if the oil be treated with nitric acid followed by a thorough washing first with water, then with a weak lye, until the solution is freed from all the acid particles. Nitric acid has a very violent action upon the oil; accordingly this operation must be performed with extreme care, especially if the preparation of large quantities is undertaken. Sample boards which had been coated with some of the carbolineum tinted with anthracene oil that had been subjected to the nitric acid treatment failed to show any deteriorating effect upon the coloring matter, of which only from 5 per cent to 10 per cent was necessary. Having mentioned above the azo-dyes which are used to color oils, fats, wax, etc., it may not be amiss to give here an important circumstance in their manufacture. They are obtained from a diazo-compound or diazotized base (aniline, toluidine, etc.), and a phenol, mostly beta naphthol (written usually β-naphthol). Now in order to obtain the clearest possible color-tone in a dye which is derived from β naphthol, it is of paramount importance that there should be absolutely no alpha naphthol (written usually α naphthol) present in the β naphthol used, since the former, when combined with the same diazo bases, will produce a dye of an entirely different character, so that if the β naphthol contain even a trace of α naphthol, a coloring mixture will result which unites two radically opposite dyestuffs. Moreover, the dye made from α naphthol is more or less water-soluble, a circumstance which must be taken into account if a durable coloring matter is to be produced. For this reason it is very necessary to be able to determine the amount of α naphthol present in a given sample of β naphthol, and Mr. J. Prochazka and Mr. H. N. Herman* show us just how this may be accomplished. "Convert the β naphthol into a naphthol-sodium by boiling together 15 grammes of

* Journal Soc. Chem. Ind., 1897, 394.

it with 200 grammes of 25 per cent soda lye, and add 140 cubic centimeters of 10 per cent soda solution, until the naphthol is completely dissolved. Now bring the solution up to 250 cubic centimeters and let it stand till it has cooled down to 5 deg. C. before using."

On the other hand, dissolve 27½ grammes of 90 per cent sodium-naphtionate in 185 grammes of water, then stir in 6.2 c.cm. (cubic centimeters) of sulphuric acid of 66 deg. Bé. This mixture having cooled to 5 deg. C., a 10 per cent solution of 7 grammes of sodium nitrite (98 per cent) may be added, stirring vigorously the while, finally bringing the contents up to 750 c.cm. Now pour this naphthionic acid liquid slowly into the sodium-naphthol solution. If the β naphthol be pure, the azo compound will fall in the form of a crystalline powder to the bottom, leaving scarcely an appreciable color in the liquor. On the contrary, if the β naphthol contain even a trace of α naphthol, the first drop of the diazotized naphthionic acid, besides causing the precipitate, will form a second dyestuff, which will impart an intensely blue color to the liquor. The liquor will turn blue even if the β naphthol contain less than 0.1 per cent of α naphthol. If diazotized naphthionic acid be continuously added to the cold liquid the reaction, by reason of the heavy precipitate, cannot be followed with the eye; if, however, the liquid be again brought to a boil, which causes the crystalline formation to sink to the bottom, the blue coloring of the upper liquid becomes again visible. From the above description of the process we see that the whole of the naphthol solution was not necessary; it was sufficient to mix only the twentieth part of the solution with the twentieth part of the diazotized naphthionic acid. It is also not imperative to boil the liquid, for a piece of filter paper may be pressed into service to exemplify the reaction. The paper is dipped into the liquid to be tested and its color compared with one produced in a solution of β naphthol containing a known percentage of α naphthol. Again, one may have at hand for comparative purposes a row of test tubes filled with dye-solutions with known quantities of coloring matter, which give the shades corresponding to reactions of certain given amounts of the two bodies, diazotized naphthionic acid and α naphthol. Very minute quantities for making tests are not advisable, yet if the operator be very careful, satisfactory results may be achieved with as little as one gramme. This work, too, may be spared, for it is possible now to obtain an almost perfectly pure β naphthol from manufactories of the first class. Dr. Liebmann some time ago proposed diazotized *paranitranilin* as a reagent, because it unites more quickly with α naphthol than with β naphthol, and therefore forms an easily soluble dye.—Translated from Farben Zeitung for the SCIENTIFIC AMERICAN SUPPLEMENT.

PREPARATION OF FIRM LUBRICANTS.

THE manufacture of these fats forms a prosperous industry, and there are well-known houses whose products are irreproachable in preparation and efficacy. But there are some who wish further information, some who are experimenting.

I. For Lubricating Machines.—The solid fat, called bakourine, which possesses extraordinary lubricating qualities, has a neutral reaction and melts only at about 80 deg. or 85 deg. C. It is prepared as follows:

A mixture is made of 100 parts of Bienne petroleum or crude naphtha, with 20 parts incorporated of some kind of mineral oil, and subjected to the action of 60 or 70 parts of sulphuric acid of 66 deg. Baumé. The acid is poured in a small stream into the oil, while carefully stirring. The agitation is continued until a thick and blackish-brown mass is obtained free from non-incorporated petroleum. Then, very cold water to the extent of two or three times the weight of the mass is added and the whole is stirred until the mass turns white and becomes homogeneous. It is left at rest for twenty-four hours, then the watery liquid, on the surface of which the fat is floating, must be poured off. After resting again from three to four days, the product is drawn off, carefully neutralized with caustic potash, and placed in barrels, ready for shipping.

II. Another Formula for Lubricating Machines.—Ten kilogrammes of tallow are melted in hot rape-seed oil, then slaked lime is added; 10 kilogrammes of lime are slaked in 40 liters of water. The mixture is kept hot, and about 70 kilogrammes of rape-seed oil are poured into it, then 100 kilogrammes of paraffine oil and finally from 25 to 30 liters of water, while continually stirring. When homogeneous, the mixture can be drawn out in long threads. Finally, while still boiling, from 500 to 900 kilogrammes of heavy paraffine oil are added. Then the fire is extinguished and the mixture left to clarify. If the fat is too thick, more paraffine oil is added.

III. For Stop-Cocks.—A mixture is made by melting together 35 kilogrammes of resin, 500 kilogrammes of tallow or beef-suet, 250 kilogrammes of lard and 130 kilogrammes of yellow wax; to this are added 130 kilogrammes of olive oil and 130 kilogrammes of spirits of turpentine.

IV. For Greasing Ordinary Carriages.—30 kilogrammes of suint are boiled with 6 kilogrammes of soda lye (20 deg.), then 30 kilogrammes of resin-oil and 30 kilogrammes of paraffine oil added, working it in. Finally, 12 kilogrammes of well pulverized slaked lime are sifted in. It is allowed to cool, while stirring.

V. For Greasing Heavy Carriages.—Cut up in small pieces in an iron boiler 25 kilogrammes of soap, add to this 25 kilogrammes of spermaceti or whale fat, then 125 kilogrammes of water; bring all to the boiling point, constantly stirring; add finally 50 kilogrammes of well pulverized talc, if white grease is desirable, or 50 kilogrammes of powdered graphite, if black grease is wanted.

VI. For Greasing Light Carriages.—Melt in an iron boiler 35 kilogrammes of resin and add 35 kilogrammes of tallow and 32 kilogrammes of linseed-oil, constantly stirring. When the whole forms a homogeneous mass, pour in, little by little 35 kilogrammes of caustic soda lye (23 deg. Bé.)

VII. For Greasing any Kind of Vehicles.—Make a mixture, hot, composed of 7 parts of fish-oil, 5 parts of slaked or fused lime; and to 100 kilogrammes of this mixture add 100 kilogrammes of resin-oil; this grease will be white.

If brown grease is wanted, to 100 kilogrammes of the soap-grease mixture add 125 kilogrammes of resin-oil and from 12 to 25 kilogrammes of the oil of coal-tar. This may be colored blue by adding Prussian blue.

VIII. For Straps.—Dissolve 2 kilogrammes of caoutchouc, cut into small pieces, in 2 kilogrammes of turpentine rectified and heated to 60 deg. C. Afterward add 1 kilogramme of ceresine, or ½ kilogramme of paraffine. In another vessel, heat 5 kilogrammes of fish-oil and 2 kilogrammes of fat, and when the whole is well melted and mixed, add, stirring, the solution of caoutchouc and ceresine.

IX. For Shoes.—Melt together and stir until the mixture is completely cooled: 48 kilogrammes of beef-suet, 12 kilogrammes of pork-fat (lard), 6 kilogrammes of yellow wax; add 6 kilogrammes of olive-oil, then 6 kilogrammes of spirits of turpentine.

X. For Preserving Leather.—Mix, hot, equal parts of oleic acid, colza-oil, colophony, spermaceti, and wax; increase the proportion of solid matters if a thicker product is desired.

XI. Another Formula.—Mix 4 parts of vaseline and 1 part of wax or ceresine; let them dissolve together and add whatever coloring matter is required.

XII. Still Another Formula.—Heat and mix together 15 kilogrammes of vaseline, 20 kilogrammes of fish-oil, 12 kilogrammes of fat and 1 kilogramme of wax; mix first the first two liquids, then let the other two be melted in them; work up the mass until as cold as possible.

XIII. For Machines.—Take 100 parts of mineral oil, 75 of linseed oil, 50 of colza oil, 100 of resin oil, 25 of lime. Slake the lime in five times its weight of water, then boil the liquid thus obtained and add to it successively the linseed and colza oils, then the resin oil and finally the mineral oil. Let the mixture boil from six to eight hours; it is ready for use, when cold. If the product is too hard, too much lime has been used.

XIV. For Machine Shafts.—Mix in a vessel, which may be placed over the fire, glycerine into which 1 per cent of sulphur has been incorporated, and castor oil into which 13 per cent of sulphur has been incorporated; heat the mixture, let it boil about half an hour. When scum forms on the surface, draw it from the fire and set to cool. The mixture is then ready to be used, especially for greasing axles and screws of machines, which have a tendency to become heated.

XV. For Printing Presses.—For greasing pinions and racks of printing presses, 1 part of yellow wax is melted with 5 parts of pork-fat and 1 part of finely-powdered graphite is added, working the mixture, until it becomes cold. If it should be too hard in winter, 1 part of crude vaseline may be added.

XVI. For Carriage Axle-Trees.—In the preceding numbers formulas for axle-grease have been given; here is another simple one, which has given excellent results. Mix 80 parts of fat and 20 parts of very fine black lead; melt the fat in a varnished earthen vessel; add the black lead while constantly stirring until it is cold, for otherwise the black lead, on account of its density, would not remain in suspension in the melted fat. Axles lubricated with this mixture can make 80 miles without the necessity of renewing the grease.

XVII. For Axles of Carriages.—Mix equal parts of red American resin, melted tallow, linseed oil, and caustic soda lye (of 1.5 density).

XVIII. Another Formula.—Melt 20 parts of resin-oil in 50 parts of yellow palm-oil, saponify this with 25 parts of caustic soda lye of 15 deg. Bé. and add 25 parts of mineral oil or paraffine.

XIX. Still Another Formula.—Mix residue of the distillation of petroleum 60 to 80 parts; tallow 10 parts; colophony 10 parts; and caustic soda solution of 40 deg. Bé. 15 parts.

XX. For Cotton Belts.—Carefully melt over a slow fire in a closed iron or self-regulating boiler 250 grammes of caoutchouc or gum elastic, cut up in small pieces; then add 200 grammes of colophony; when the whole is well melted and mixed, incorporate, while carefully stirring, 200 grammes of yellow wax. Then heat 850 grammes of train-oil, mixing with it 250 grammes of talc and unite the two preparations, constantly stirring, until completely cold.

XXI. For Hunting Boots.—Melt over a slow fire 6 kilogrammes of tallow; 1 kilogramme of beeswax; 2 kilogrammes of fish-oil; 1 kilogramme of stearine. The product thus obtained, known by the name of trapper's grease, is quite suitable for preserving hunting boots.

XXII. To Test Fat.—To be assured of the purity of fat, its density is examined as compared with water; a piece of fat of the size of a pea is placed in a glass of water. If it remains on the surface or sinks very slowly, the fat is pure; if it sinks rapidly to the bottom the fat is mixed with heavy matters and coom is the result.—Translated for the SCIENTIFIC AMERICAN SUPPLEMENT from Science Pratique.

RADIUM RAYS.—E. Rutherford brings some interesting information concerning the three classes of rays obtainable from radium, which element certainly deserves its name. There are the *a*-rays, consisting of heavy positively-charged particles; the *b*-rays, identical with cathode rays and negative electrons; and the *c*-rays, which are not deflected by a magnet, and can penetrate 8 cm. of aluminium as against the 0.05 cm. of the *b*-rays and 0.0005 cm. of the *a*-rays. The author proves that *a*-rays are also deflected by a magnet of sufficient strength, although the radius of curvature of their path is 39 cm. in a field in which cathode rays would show a radius of curvature of only 0.01 cm. radius. The author proves the magnetic deflection by passing the rays through a number of parallel plates with narrow interspaces, in which the least deflection will lead to absorption. He finds that the velocity of projection of the *a*-rays is about one-tenth of the velocity of light, and their ratio e/m roughly 6,000. He supposes that the particles projected are intermediate between atoms and electrons. These *a*-rays are identical with polonium rays, but much faster than canal rays. They are the chief agents in the dissipation of matter and energy from radio-active bodies.—E. Rutherford, Physikal. Zeitschr., January 15, 1903.

CATATYPY.

A NEW PRINTING PROCESS WITHOUT LIGHT, A NEW EPOCH IN PHOTOGRAPHY.

IT is a well-known fact that the reactions of the compounds of silver, platinum, and chromium in photographic processes are generally voluntary ones and that the light really acts only as an accelerator, that is to say, the chemical properties of the said preparations also change in the dark, though a longer time is required. When these preparations are exposed to the light under a negative, the modification of their chemical properties is accelerated in such a way, that through the gradations of the tone-values in the negative, the positive print is formed.

Now it has been found that we also have such accelerators in material substances that can be used in the light, the process being termed catalysis. It is remarkable that these substances, called catalyzers, apparently do not take part in the process, but bring about merely by their presence, decomposition or combination of other bodies during or upon contact. Hence catalysis may be defined, in short, as the act of changing or accelerating the speed of a chemical reaction by means of agents, which appear to remain stable.

Professor Ostwald and Dr. O. Gros, of the Leipsic University, have given the name of "catatypy" to the new copying process. The use of light is entirely done away with, except that for the sake of convenience the manipulations are executed in the light. All that is necessary is to bring paper and negative into contact, no matter whether in the light or in the dark. Hence the negative (if necessary a positive may also be employed) need not even be transparent, for the ascending and descending action of the tone-values in the positive picture is produced only by the quantity in the varying density of the silver powder contained in the negative. Hence no photographic (light) picture, but a catatypic picture (produced by contact) is created, but the final result is the same.

Catatypy is carried out as follows: Pour dioxide of hydrogen over the negative, which can be done without any damage to the latter, and lay a piece of paper on (sized or unsized, rough or smooth, according to the effect desired); by a contact lasting a few seconds the paper receives the picture, dioxide of hydrogen being destroyed. From a single application several prints can be made. The acquired picture—still invisible—may now in the further course of the process, have a reducing or oxidizing action. As picture-producing bodies, the large group of iron salts are above all eminently adapted, but other substances, such as chromium, manganese, etc., as well as pigments with glue solutions, may also be employed. The development takes place as follows: When the paper which has been in contact with the negative is drawn through a solution of ferrous oxide, the protoxide is transformed into oxide by the peroxide, hence a yellow positive picture consisting of iron oxide results, which can be readily changed into other compounds, so that the most varying tones of color can be obtained. With the use of pigments in conjunction with a glue solution, the action is as follows: In the places where the picture is, the layer with the pigments becomes insoluble and all other dye-stuffs can be washed off with water.

The chemical inks and reductions, as well as color pigments of which the pictures consist, have been carefully tested and are composed of such that are known to possess unlimited durability.

The costs of the process are very slight and the working is most simple. After a short contact, simply immerse the picture in the respective solution, wash out, and a permanent picture is obtained.

If this new process should prove a success in practice, we are indeed about to enter a new epoch in photography.—From the German of E. Hirsch, in Deutsche Photographen Zeitung.

SUEZ CANAL STATISTICS.

ACCORDING to a parliamentary return just issued in London the net tonnage passing through the Suez Canal for the past year shows an increase of 424,573 tons as compared with that of 1901, and of 1,510,261 tons as compared with that of 1900. The transit receipts for 1902 amounted to 103,720,020 francs and were higher than in any previous year since the opening of the canal, showing an increase of 3,333,623 francs, as compared with those of 1901. The British Suez Canal directors remark that no special reason can be assigned for the increase in the trade through the canal except that the economical situation of India has recently improved, and that there has been an increased activity in the trade with the East. The number of vessels which passed through the canal was 3,441 in 1900, 3,699 in 1901, and 3,708 in 1902, of which 1,935 in 1900, 2,075 in 1901, and 2,165 in 1902, carried the British flag. There was an increase last year as compared with 1901 in the tonnage of British vessels which amounted to 5,605,421 tons in 1900, 6,252,819 tons in 1901, and 6,772,911 tons in 1902. During the same period the tonnage of German vessels fluctuated from 1,466,391 tons in 1900 to 1,762,624 in 1901, and 1,707,322 tons in 1902. Of 2,738 merchant vessels and vessels in ballast, of a net tonnage of 8,061,483 tons, passed through the canal in 1902, 1,906 ships of a net tonnage of 5,848,460 tons were British, being 67.7 per cent of the number and fully 72.5 per cent of the tonnage; 332, or 12.2 per cent, were German vessels whose tonnage was 13.3 per cent of the whole; France, Holland, Austria-Hungary, and Russia, combined, furnishing a total of 13.2 per cent of the vessels, and 11.5 per cent of the tonnage of the carrying trade to the East through the Suez Canal. In the ten years, 1891-1900, the annual net tonnage ranged from 8,698,777 tons to 9,738,152 tons, and the transit receipts from 83,422,101 francs to 90,623,608 francs. The average of the net tonnage was 8,588,947 tons, and of the transit receipts 80,000,013 francs, while in 1902 the net tonnage amounted to 11,248,413 tons, and the transit receipts to 103,720,020 francs. The mean net tonnage per vessel, which in 1891 was only 1,517 tons, rose from 2,067 tons in 1891 to 2,830 tons in 1900, to

2,926 tons in 1901, and to 3,034 tons in 1902. During last year the canal was used thirty-nine times by steamers exceeding 150 meters (492 feet) in length, or more than 18 meters (59 feet) in breadth. The number of troops carried through the canal during last year amounted to 89,946, as against 136,514 in 1901, being a decrease of 51,568. There was an increase of 8,258 British, 272 American, and 130 Portuguese, against a decrease of 21,597 Russian, 17,677 German, 13,433 Turkish, 6,743 French, 600 Italian, 245 Japanese, and 176 Dutch troops, as compared with 1901. The number of civilian passengers amounted to 98,213 in 1902, as against 92,046 in the preceding year, being an increase of 6,167, while the number of pilgrims, emigrants and convicts was 40,499 in 1902, as compared with 41,661 in 1901, or a decrease of 1,162. In the year 1870, 26,758 civil and military passengers were carried through the canal; in 1880, the number rose to 98,900; in 1890, to 161,352; and in 1902, to 223,775, as against 270,221 in 1901.

TRAIN LIGHTING WITH STEAM TURBINES.*

By GEHEIMRATH WICHERT.

IT is not my intention in this communication to decide which of the present existing train-lighting systems is the best.

Railroad managements favor neither gas lighting nor electricity, and install them only where obtained at a reasonable figure. All improvements made in the field are thoroughly examined.

The particulars of the train lighting systems which were in existence before will not have our attention to-day. I refer, in connection with this matter, to Dr. Buettner's book "On the Lighting of Passenger Cars, With Special Reference to Electricity," who, with marked impartiality speaks of the usefulness of the different systems.

The ideal for railway [illegible] lighting which have been [illegible] mission [illegible] which each car, without any special preparation, is always ready at any time for lighting purposes, and for any period. Consequently inventors have taken special trouble to build machines which answer these requirements as much as possible. In such systems a dynamo is carried on each car, and is driven from the axle; also a small battery, from which the power is taken when the car is at rest, or when the dynamo is disabled. In addition, each car is provided with regulating apparatus, rendering the lamp current circuit independent of the train speed or the charge of the batteries when the speed of the train surpasses a given ratio or drops below a certain point.

These regulating devices are very ingenious and are extraordinarily accurate, but their maintenance is difficult. They have been introduced by Stone, Vicarino-Pollak, Dick, and others. The Stone device has been introduced of late on a large scale in England, apparently with good results. Whether it will really maintain its good reputation, remains to be seen; the experience which has been acquired here with a few devices has not exactly inspired confidence, nor been encouraging. One of the drawbacks which I would especially dwell upon, is that the devices for generating great lighting power, such as we now use, are very expensive, and that the dynamo, when no light is needed, revolves with the axle, thereby running without load and increasing thereby the operative expenses. For certain purposes, i. e., for drawing-room cars, which journey long distances, this system of electric lighting is really the only one practicable; the power required is derived from the car axle, and the small battery is kept constantly charged, so that a breakdown of the lighting system cannot take place.

In the other method of lighting cars individually the electrical energy is stored up in the car and carried with it. For this purpose batteries are carried, the capacity of which is sufficient for a given time. This system can be so arranged that the batteries can be charged without being removed from the car, or else changed and charged in the power station. The last mentioned system is much used on postal cars. Virtually, this last mode of electric lighting is equivalent to our system of gas lighting, as in this case the gas supply is also stored up only for a given time. This type of individual car lighting works satisfactorily and has been largely used in the German postal service. It has the advantage of not decreasing the hauling power of the locomotive. The chief drawback of this system is the size of the batteries to be carried; for the higher the lighting power the larger the battery must be. The expenses will be proportionate, and for such a large system as that of the Prussian State Railroads, the management believes it could hardly be carried through practically.

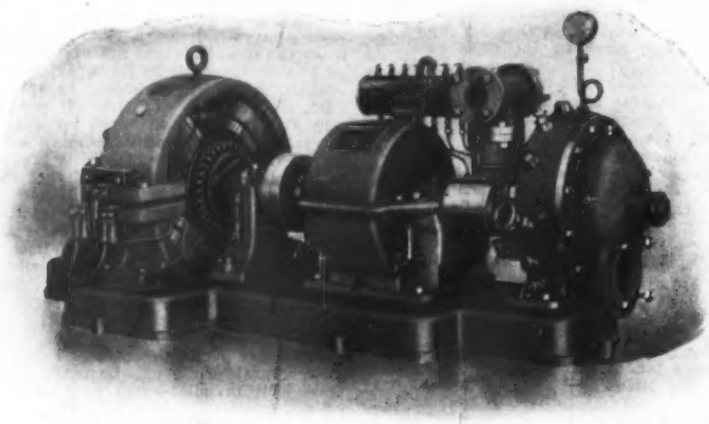
Considered from the point of view of service, the independent car system has the advantage. Although each car is fitted with air-brake, gas and heating pipes, being connected with those of the next car, each one can be handled separately. The electric conductors running from car to car are connected in the same manner as the steam and brake pipes, making one block of the train, whereby great advantages over single car lighting are obtained.

As we use for the whole lighting of the train only one dynamo or generator, which can be easily inspected, it follows that if the train could be run constantly in the same formation we could even operate with one set of batteries. We shall never be able to dispense with batteries entirely, because, if solid block trains were to carry only one set of batteries, and the dynamo should give out, what would be done?

Electric lighting is the simplest and most easily applied system when trains are propelled by electricity. The current may be drawn from the power conductor, as on street railways. But the light is not uniform and gives out, if only for a short while, at crossing points or other interruptions of the main conductor. These inconveniences can be endured on short rides, but not on a standard trunk line.

In the case of a complete train lighting device we have three propositions before us. The dynamo can be located either inside or outside the car, and be driven by the car axle; this offers, as in the case of individual car lighting, the inconvenience of requiring a special regulating apparatus to equalize the fluctuations of current resulting from the variation in the speed of the train, as well as disconnecting and connecting the batteries from the generator at the right moment. Further, the source of power can be located in a special car, for instance, a boiler and steam engine which drives a dynamo.

This system offers the advantage of rendering the lighting equipment independent of the speed of the train, and also the advantage of not decreasing the hauling power of the locomotive. The drawback of this system lies in the fact that the space taken up in the car is considerable, and special attendance is needed. The third proposition consists in locating a power generator, and a dynamo utilizing its power, on the locomotive. This is the simplest device, a special attendant not being needed, as the engine driver can attend to its running. Each of the systems mentioned offers different advantages and disadvantages which must be well considered before a selection is made.



30 H. P., 20 K. W. DE LAVAL TURBINE DYNAMO USED BY PULLMAN COMPANY.

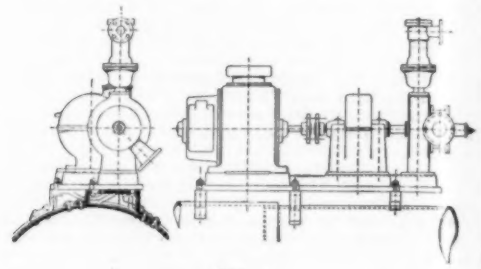
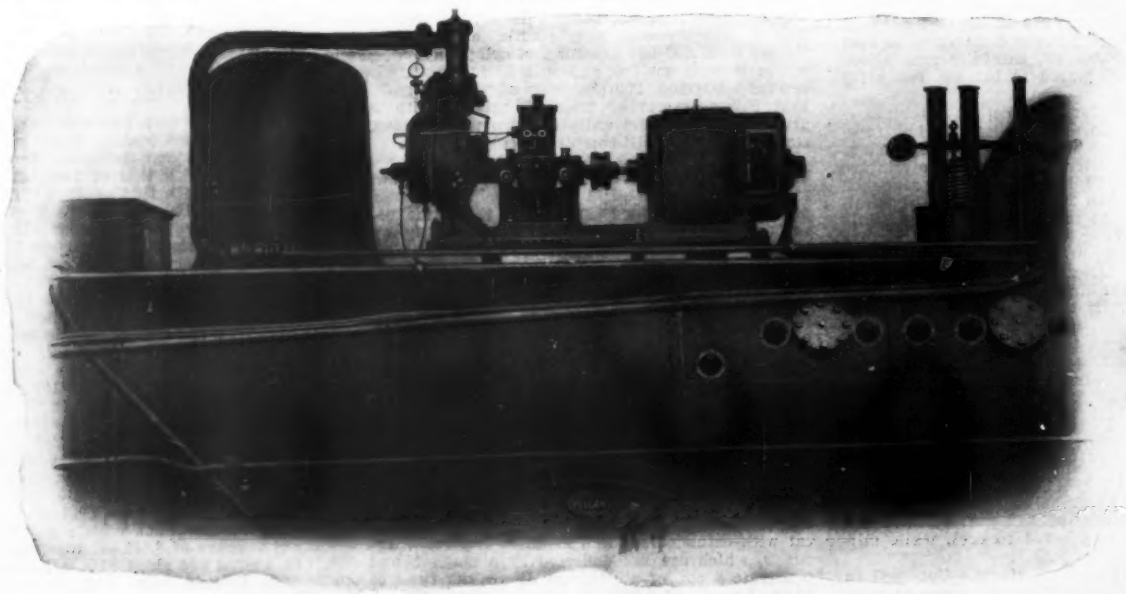


FIG. 1.

These questions have been considered and studied on all sides by the Prussian Railroad Direction who decided ultimately to push the trials to an end, and decided to select the last mentioned system, that in which the motor and dynamo are located on the locomotive, each car being provided with a set of batteries.

It was thought that by adopting this system, a serviceable equipment would be secured, which would keep the maintenance expenses down to moderate limits, and which above all, would be easily handled and trustworthy. For the same reasons it was sought as much as it was possible, to avoid all movable regulating parts or complicated devices, so that the care of the equipment could be given to employes without fear of damage through rough usage of the apparatus. The first experimental equipments were put on two steam trains running between the Stettin local depot and Stralsund Sassnitz. These trains were selected because they do not run in connection with other trains, and were, therefore, well adapted for the purpose. Moreover, these trains operate under the increased difficulty of being ferried over from Stralsund to Altefahr without a locomotive, and owing to the schedule, each train has to run back from Stralsund to Sassnitz and return, the current on these runs not being derived from the engine generator but from the batteries. A similar state of affairs will frequently occur on a number of trains which may happen to run on foreign tracks, on which the locomotives are not equipped with electric generators, nor in charge of men to attend to the equipment with due care. In the trials which are being made, one train began operation on the twenty-



20 H. P., 13.2 K. W. TURBINE DYNAMO AS USED ON PRUSSIAN LOCOMOTIVES FOR TRAIN LIGHTING.

* Abstracts translated from a report on the Prussian National Railways, presented at the German Engineers' Convention, April 23, 1903.

first of March, the second on the third of April, and both have given satisfaction. A few breakdowns of very little consequence, owing to the "tuning" of the apparatus, have happened, but they were to be expected and would have happened with any invention in the perfecting stage.

It is, therefore, the intention to run two more steam trains between Berlin-Altona, in each direction, and those in connection between Hagenow and Kiel, and equip them with electric lighting.

On the first experimental trains, the so-called Swedish train, steam cars of the old type of construction were used. For the sake of simplicity and to save time, the old compound lighting chandeliers were retained, and electric bulbs substituted for the old burners. In the Hamburg trains which were run in summer, new cars have been used and new electroliers have been put in.

The general apparatus on the experimental trains is very simple, as I have already said. On the locomotive a shunt-wound dynamo, driven by a De Laval steam turbine is located. Both are riveted to a common bed plate, and located on the locomotive, as stated, and in such a manner that the view of the engine driver is not impeded in any way. The two main conductors start from the binding posts of the dynamo and are carried throughout the whole train, from car to car, by means of plug connections. In each car a battery composed of 32 cells is switched in parallel with the mains to the dynamo. The circuit by which the lamps are fed is also connected with the same mains. A special resistance is provided for every lamp, through the influence of which the lamp current is kept constant. During the run, the dynamo generates an electric current of 60 volts tension, which can be raised to 90 volts during charging; the batteries can be discharged at a voltage from 64 to 58 volts, while the lamps are fed with a current of 48 volts. This great difference between the lamp voltage and that of the field must be counteracted by means

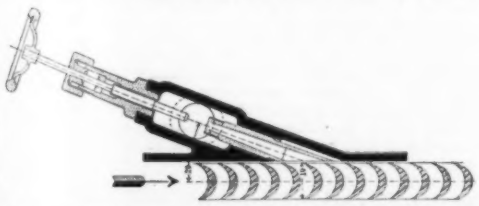


FIG. 4.—ARRANGEMENT OF STEAM NOZZLES WITH TURBINE WHEEL OF 20 H. P. DE LAVAL TURBINE.

of the resistances. The size and arrangement of the system is to be proportioned to the number of lamps required in the car. This depends on the expense to be incurred, and on the load to be put on the locomotive.

Experience has proven that for general lighting purposes no better disposition can be adopted than the one existing in the new four passenger compartment cars, fitted up with mixed gas light, in which two lamps, each located on the edge of the skylight, are provided for each compartment. The trials which are being made with the equipment at present, have shown that, at the height at which one holds a paper to read, one has a very good light at every seat. In addition to the general lighting equipment, the first and second-class cars have been supplied with reading lamps, two in number, which are fixed to the wall over the back rest.

Each of these reading lamps has a special switch enabling the traveler to turn the light on or out. A shade fitted over each lamp keeps the strong light out of the eyes of the traveler, and also protects the lamps against injury from parcels.

The lighting power is as follows:

Ceiling lamps in the first-class compartment cars, twenty normal candles; for second-class of the same construction, sixteen normal candles; and twelve normal candles for the third-class cars of the same construction. In each case two lamps are provided, either of sixteen or twenty candle power, the power of the lamp depending on the size of the compartment. The lamps of the outer rooms are of twelve candle power, and the reading lamps are six candle power.

To ascertain the power required a few assumptions must be made. The most light is required in the first and second-class compartment cars provided with corridors. Each is equipped with six twenty-candle ceiling lamps, eight, ditto, sixteen candles, nine, ditto, twelve candles, and twenty-eight reading lamps of six candles each, forming a total of five hundred and twenty-four normal candles. As the lamps use 1, 2, 0.8 and 0.4 amperes, they require an aggregate current of 33.6 amperes.

If for the present, all reading lamps are taken into consideration, not all of them being lighted, the lamps for three hundred and fifty-six candles will consume 22.4 amperes. A third-class car uses 16.8 amperes.

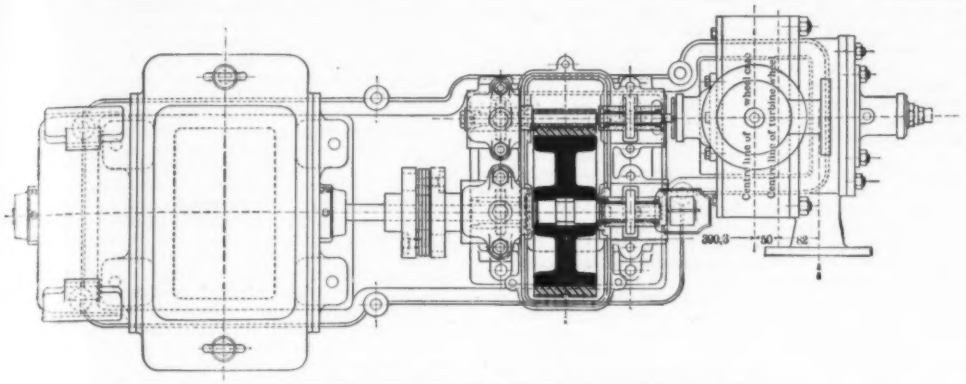


FIG. 3.—DE LAVAL STEAM TURBINE DYNAMO 20 H. P.

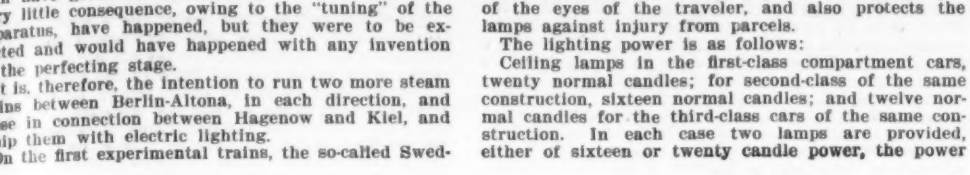


FIG. 2.—DE LAVAL STEAM TURBINE DYNAMO 20 H. P.

Take for example, a train of ten four-axle cars composed as follows:

Four cars first and second class,
Four cars third class,
One baggage car,
One postal car,

the consumption will then be, without the reading lamps, 160 amperes. If all the reading lamps were in service, then 44.8, or in round figures, 45 amperes more would be required, and would constitute for the whole train a total of 205 amperes. In reality the consumption will never be so high, because all the reading lamps will not be in use at once. This proposition would correspond to a train of forty axles—which is the heaviest load of our fast trains—and it should, therefore, answer to all requirements.

It is, however, accepted that the train is composed half of third class cars and half of first and second class; should there be only first and second class the expenditure of power would be greater.

A dynamo capable of generating 180 amperes has been selected; this amount is not quite the power required when the reading lamps are all used.

The tension of the current generated by the dynamo is 68 volts, which requires an engine of 20 horse power. The dynamo and the motor can generate 10 per cent more, so that there is a safe margin at hand. It will be nearly always possible to get the necessary current from the dynamo. Only when very heavy

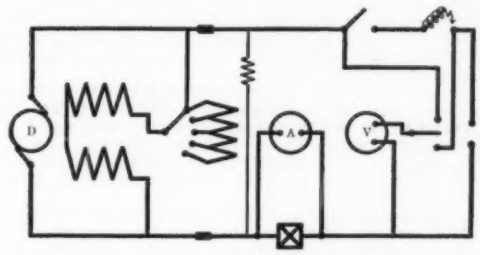


FIG. 6.—DIAGRAM OF WIRING ON LOCOMOTIVE.

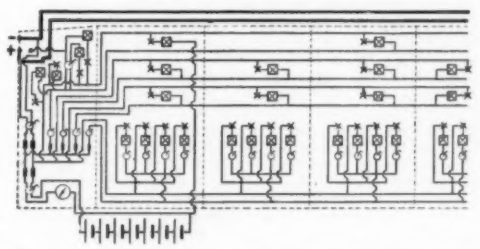


FIG. 7.—DIAGRAM OF WIRING FOR FIRST AND SECOND CLASS CAR.

trains are handled will the reserve stored up in the batteries be resorted to. In general, the batteries will be used only as a reserve. On the Swedish train a turbine of only 15 horse power is used, because the trains on that line are lighter; but experience has shown that it is expedient to use a more powerful motor in future equipments.

The De Laval turbine, whose propelling shaft is coupled with the dynamo, is located on the same bed plate as the dynamo, both being riveted on the top of the boiler. The arrangement, as well as the detail cuts, are shown in Figs. 1 and 5 so clearly, that it needs no further explanation. The turbine revolves 20,000 times per minute, the dynamo 2,000 times. The steam is introduced through three nozzles. The governor operates on the steam valve and controls the speed very effectively under various loads. Turbine and dynamo are seated on a bed plate insulated from the boiler by small blocks so that the heat cannot affect them. Protection is afforded against dust by inclosing the whole apparatus in dust-proof casing.

The turbine is well suited for its special purpose. Only the revolving parts require attention. The regulation is perfect, and the wearing down is small. Unfortunately, however, the consumption of steam is rather high, and when under full load, is from 19 to 20 kilogrammes for the horse power used per hour. When it is considered that the locomotive requires hourly for the horse power needed, a steam capacity of 10 to 11 kilogrammes, it means, in other words, that this turbine diminishes by 20 horse power the power capacity of the locomotive for the train service, of at least 35 horse power. This is not always convenient. However, the decrease is not serious, and the propor-

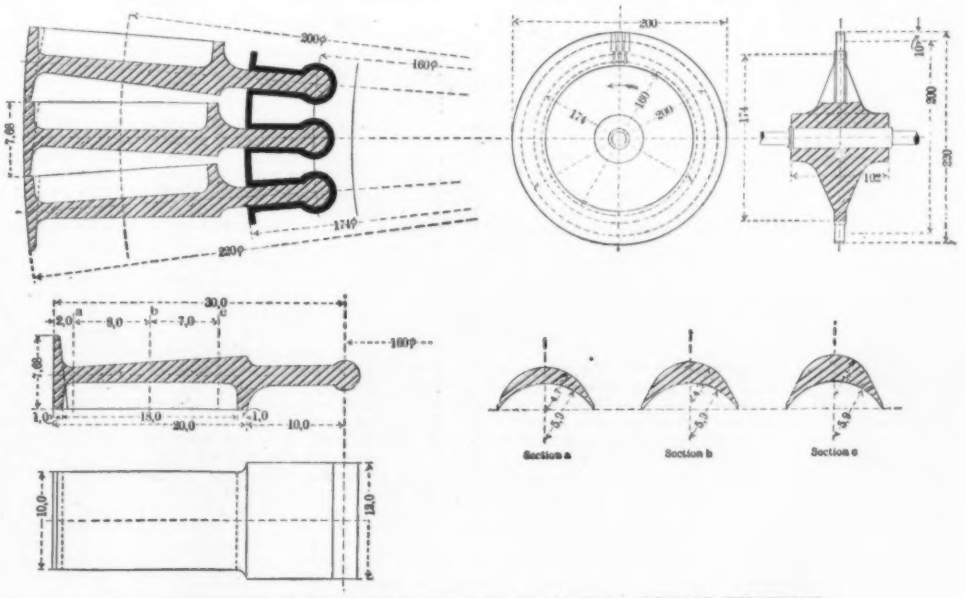


FIG. 5.—TURBINE WHEEL FOR 20 H. P. DE LAVAL STEAM TURBINE.

tion of one to the other is such that they balance. The boiler must not only provide steam for the locomotive, but also for the air pump of the brakes, the heating of the cars, and for the turbine of the electric light equipment. Although the consumption may be great the hauling power of the engine is not diminished. Still, it is very important to decrease in a certain measure the consumption of steam of the turbine, if only just for the purpose of increasing the lighting power correspondingly. The possibility of decreasing the steam power has not yet been settled. It is a question which will have to be taken up by the builders.

If we take stationary plants as an example, it is easily seen that condensing apparatus can be installed by means of which the consumption of steam would be brought down to nearly half the present. In winter, nothing prevents us from leading the turbine exhaust into the heating pipe line. In this way a considerable quantity of steam can be saved.

Superheating the steam before sending it to the turbine, by piping it through a special coil of pipes located in the smoke box, would result in another notable economy.

To conclude, nothing proves that a more economical turbine than the De Laval exists. At first it was the intention to use a Parsons turbine, the speed of which is lower (3,000 to 4,000 per minute). But the Parsons turbines, which are supposed to work very economically, are not built in the small sizes which we speak of.

The dynamo is, as I have already said, connected direct to the extension shaft of the turbine. The dynamo is shunt wound, and generates a current of 180 amperes at 68 volts tension; the machine, however, can generate 10 per cent more. The apparatus is shown in Figs. 2 and 3. The scheme of the wiring on the locomotive is shown in Fig. 6.

The engine driver has to attend to the following: When his engine is coupled to the train, the whole system of lines is united, the batteries being kept charged, the current circulates when they are switched in. The switch being opened, the engine driver starts the dynamo so as to generate a current which nearly equals the tension in the line. It is only at that moment that he closes the switch, the dynamo being switched in parallel with the batteries. If he desires to measure the voltage of the line or dynamo, he simply has to switch in the voltmeter.

When switching off the dynamo the engine driver must nearly balance it with the voltage of the batteries. When the dynamo generates but little current, the switch is not to be thrown open, and only then can the tender and baggage car be uncoupled. Regierungsrath and Baurath Wittfeld has devised an automatic safety switch to prevent burning out of fuse and to take the place of the usual untrustworthy automatic switches.

The wiring of the lines and the switching of the batteries is shown diagrammatically. Fig. 7 shows the arrangement of the trains between Berlin and Altona.

In the new cars four distinct lamp circuits have been laid out, each being capable of being operated singly. In one system, the reading lamps belong to the circuit in which the ceiling lights are arranged, in the second circuit the lamps on the sides of the ceiling are fed, the third one feeds the lamps in the corridors and outer rooms, and the fourth, the reading lamps.

The switches are all inclosed in a cabinet and are to be operated only by the porter; each of the reading lamps has a switch which can be operated at will by the passengers. The cabinet also contains a circuit breaker for the dynamo current, another for the battery current, and speed direction indicator, also contacts to connect a voltmeter to measure the voltage of the batteries.

To avoid irregularities a few devices are to be installed in the cars as follows: A ceiling lamp in the side lobby is switched between the line of the ceiling lamps and that of the batteries. It can, therefore, burn only when the batteries are switched in. Should the battery, therefore, be cut out by mistake, the porter as well as the engineer will be warned of the fact when the lamp does not glow. Another arrangement will be introduced according to Mr. Wittfeld's advice, its purpose being to attract the attention of the porter and the engine driver, when the connecting cables running from car to car are not properly coupled. As can be seen in Fig. 7, a red and white lamp are cut in the circuit; if the circuit is fed by the batteries both lamps are then burning; should the current be cut off by the circuit breaker, then both lamps go out. The connection with the dynamo is arranged in such a manner that the connection is set when the plug contacts of the connecting cables are gradually pushed in. The connection is so devised that the signal lamp is set to burn, even though the lamps should be extinguished.

When the coupling is done properly the white lamp burns. Should the red lamp burn, this will attract the attention of the porter who, according to his instructions, is ordered to extinguish it; should the white lamp at that moment also go out, it will indicate to him that the coupling is not properly set. The red lamp is to burn only on independent through cars, to indicate that the neighboring car is not electrically illuminated.

The battery with which each car is provided equalizes the voltage, and also furnishes the current required when the dynamo does not run, or when the locomotive is uncoupled, or for through cars. The capacity of the battery is such that it is alone capable of furnishing the lighting of the car for several hours.

As a matter of principle the batteries carried by all cars are of the same capacity, each composed of 32 cells, having a tension of 64 volts and a 75 ampere hour capacity at a high discharge rate. Each element is inclosed in a hard rubber cell; each group of four elements is incased in a wooden box, and the group of four boxes is united in a portable wooden crate. Each car carries two sets of batteries in separate boxes underneath the frame, so arranged, that, by simply pushing them in place, the connections are established. On the through cars two sets of batteries are carried of twice as long lighting capacity as the others. The length of the lighting capacity depends on the number of lamps carried by the car. Should the train be hauled by a locomotive not fitted with an electric generator, as is the case between Stralsund and Sassnitz, then the batteries work altogether, and the lighting capacity is regulated by the number of lamps to be fed. On a first and second class car, equipped as stated above, the battery will insure the full lighting for two and a half hours. When the ceiling lamps are partly extinguished in the compartments, the lighting capacity will be increased to three and a quarter hours, and without reading lamps, seven hours. On the through cars the time limits are increased twice as much.

I will now deal with one of the most important points of the whole system, i. e., the disposition of the regulating resistances, whose purpose is to keep the lights as nearly steady as possible. I have already said that a certain number of movable regulators of different and very ingenious patterns were invented and applied, but which were much too delicate to be put in the hands of railroad employes. It was, therefore, necessary to find a device in which all movable regulating parts could be entirely excluded. Regierungsrath and Baurath Wittfeld has succeeded in devising such a contrivance which is based on the fact that bismuth changes its resistance under fluctuations of the field magnitude. Bismuth has been utilized to construct a device in which under changeable tension in the circuit, a current, very nearly constant, feeds the lamps, by which the bismuth resistance is cooled and maintained at an even temperature. The wiring combination used for the purpose gave, under very small voltage fluctuations, considerable changes in the power of the field. Chief Engineer Dr. Buettner proved that the device could be simplified and cheapened if it was not to be operated with an even temperature resistance, but with a changeable temperature and also a ballast resistance. This led to experiments with the iron resistance of the Nernst lamps used by the Allegemeine Elektricitäts-Gesellschaft.

The resistance is switched in in the Nernst lamp by the incandescent mantles used. It is primarily employed to prevent too large an increase of the current, which, on account of the negative temperature coefficient, would be switched in, when this one alone is in the circuit. It was expected that it would also adapt itself for the purpose of rendering the lamp current independent of the tension of the line circuit. Its utility was recognized after an extensive trial, so that it appeared practicable to employ this device as a switch in connection with the lamp. Up to the present these iron resistances have proved themselves durable in operation.

The outward shape of the resistance resembles an incandescent lamp. A fine iron wire is melted in a glass tube in which its ends are united with the two pole terminal. The glass tube is filled with hydrogen under a given pressure to afford the possibility of a certain cooling down of the wire through the walls of the tube, and thence through the surrounding atmosphere. Cooling is automatically regulated by the gas pressure inside the tube.

The resistance of iron wire increases markedly with the temperature. A difference in the tension of the line circuit of the resistance will call for a change in the power of the current. This change can, however, not become important as it immediately causes a strong rise or lowering of the resistance following the consequent change of temperature. The iron resistance is really an automatic regulator, which causes the lamps to receive a nearly even current and causes them to burn regularly.

Each special lamp requires special resistances, and the equipment is so devised that changes cannot be made unless the right resistance be switched in before the corresponding lamp.

Unfortunately, a considerable energy is absorbed by the resistance. I do not know that it can be avoided. As I have previously stated the normal lamp tension of the current indicator is 68 volts; the lamps burn with a tension of 48 volts. The loss is therefore 30 per cent. It may be possible to devise means by which the loss will be considerably less.

By this time you will have convinced yourselves, after what you have heard regarding the equipment of the first trial train, although not completely carried out, that the selected arrangement of car lighting, and the attendance it requires are very simple. The engine driver has nothing further to do when he comes on the train, but to inform himself of the tension of the batteries, then to cut the dynamo in, and to keep the voltage at 68 volts during the run. Everything else is cared for automatically. When the engine is to be uncoupled from the train, the engine driver regulates the clamp tension of the current indicator in such a way that the current, which is flowing to the train, has but very little intensity left. Then he throws the main switch open and shuts down the dynamo.

The porter has principally to attend to the switches, and to see that they are tight, that the resistances and lamps are not burnt out, the connections from car to car properly established, etc.—conditions which can be easily ascertained from the control lamps mentioned before. He has also to see that when the train comes to the end of the run the batteries are fully charged. This can be ascertained by reading the voltmeter he has at his service. Should the batteries not be full, they must be charged either before or during the run. This can be done most readily in the day by raising the charging voltage through regulation of the dynamo voltage to about 90 volts. When the trains are very long and the current power required can not be generated entirely by the dynamo, the batteries will then have to be brought into play to help. If in this case, their output does not then reach the current power required, the porter will then have to put out some of the lamps. The condition of the batteries is ascertained at the depot where the trains are made up.

Eucalyptus wood a native of Australia, but now largely grown in California, is said to make excellent stamp stem guides. There are a great many varieties of this wood, but the red gum is said to be superior for the purpose indicated, requiring a minimum of lubrication.

MANUFACTURE OF STEEL BY THE ELECTRIC FURNACE.*

ONE of the striking features of the French people is that imaginative quality which finds expression in the creation of things fanciful. To-day the world of fashion pays tribute to its genius. Even in the world of commerce this quality voices itself, but in no case more poetically than when it calls the tumbling torrents of the Alps, utilized for the generation of electric power, "*la houille blanche*," or literally "the white coal." The comparison with *la houille noire* is evident.

The writer was privileged to attend during September *le Congrès de la Houille Blanche*, held at Grenoble, when between 500 and 600 members made a tour embracing the departments of Savoy, Upper Savoy, and Isère—a region abounding in water powers, developed and undeveloped. It is in this Alpine region, most liberally endowed by nature, that the electro-chemical and electro-metallurgical industries have made greater progress. The established industries, while comparatively young, are well known, but special interest attaches to one of the newer branches of electro-metallurgy, the manufacture of steels by means of the electric furnace.

The remarkable development of steel manufacture in the United States within recent years lends a special interest to the electric furnace phase of the question, and one naturally stops to think what changes may be induced by the introduction of this new factor. That it is a factor no one conversant with what has been done will challenge. In France many capable metallurgists are at work developing electro steel making, such, for instance, as M. Harmet, at St. Etienne; M. Chavarria-Contardo, at Paris; M. Heroult, at La Praz; Keller, Leleux & Cie., at Morbihan, and others. Steel of excellent quality is already being produced, and it will surely not be long before the electric furnace assumes a strong position as a fixed factor in steel making.

In the United States the proximity of extensive water power developments to the Lake Superior ore deposits and similar installations close to the titaniferous iron ores in New York State and Canada must awaken the interest of our metallurgists to the growing possibilities of the electric furnace.

It would be well-nigh impossible in a single article to detail all that has been accomplished in France, but by following one certain process we may perhaps gain a fair idea of the general progress. The Cie. Electro-Thermique Keller, Leleux & Cie. erected a factory at Kerrousse, near Hennebont, in the Department of Morbihan, principally intended for the manufacture of carbide of calcium. The decision of the French courts awarding to M. Bullier all rights to make carbide of calcium in France prevented the operation of the works for that purpose and necessitated the substitution of another product. The apparatus for electro-metallurgical operations being available, the firm took up the manufacture of various ferro alloys and the treatment of iron ores upon a large scale. However, the manufacture of ferro alloys by electric furnace means is fairly well understood, and this article deals more particularly with the younger branch, which appears to be "the order of the day" with metallurgists, "The Electrical Manufacture of Steels." The use of the plural should be noted, for by the electric furnace it has been shown that all grades, from open-hearth to the finest tool steels, can be produced. The writer has seen in the office of Keller, Leleux & Co., in the Rue Vignon, Paris, specimens of steel of various grades which compare very favorably with similar grades made by older methods.

DESCRIPTION OF THE WORKS.

The Kerrousse factory utilizes the waterfall of Blavet, by means of which about 550 horse power is developed. The motive power consists of four vertical turbines of 135 horse power each, which by means of suitable clutches can be coupled at will to a single horizontal shaft operating two alternating current generators of 200 kilowatts each, with two exciters, one of which is held in reserve. These alternators are so constructed as to give current at three different voltages, by changes in the outer coils. This plan is of great assistance where it is desired to operate various types of furnaces, or manufacture products requiring variations in voltage at different stages of the process.

The furnace room contains a battery of various types of electric furnaces for the manufacture of alloys, which occupy about one-half of the floor space; the other half being reserved for special furnaces for the treatment of iron ores and the manufacture of steels.

There is also a large electrical and chemical laboratory attached to the works, a grinding room and equipment for the manufacture of electrodes.

Before proceeding to a more detailed description of the process it might not be out of place to say a word about its origin and development. From information which has been gathered it appears that M. Keller obtained his first satisfactory results in the treatment of iron ores with the type of electric furnace which he styles the "two-electrode furnace" (*four à deux électrodes*), designed in 1889, and which he exhibited for the manufacture of calcium carbide at the Third Acetylene Congress, in September, 1900.

TWO-ELECTRODE FURNACE.

This type of furnace employs two electrodes placed vertically side by side, each connected to the terminals of the dynamo. The walls of the furnace are of masonry and there is a refractory hearth, as in the ordinary types.

The operation and regulation of this furnace are such as to produce in the neighborhood of each electrode a sort of thermal focus, or distinct zone of reaction and high temperature, these two high temperature areas being put in series by the fused and partially fused materials under treatment. In this manner each zone is capable of being separately regulated and the sphere of greatest activity increased or diminished as may be desired.

The electric current enters by one electrode, traverses the fused or partially fused materials, by means of which the temperature of the mass is maintained or raised as may be desired, and then passes out by the

* Translation published in Iron Age with additions by P. McN, Resume of a paper by Charles Bertolus of St. Etienne, France, entitled, "Notice sur la Fabrication des Aciers au Four Electrique."

other electrode. The arrangement of the furnace thus permits of changes in the zone of caloric action at either electrode by simply changing the position of the electrodes.

The employment of two thermal foci within the same furnace body permits of the use of larger and more powerful apparatus than would otherwise be feasible. However, the two-electrode type does not fully meet the desiderata of modern metallurgical operations:

1. Continuity of operation within the same apparatus.
2. The employment of apparatus of large capacity.

The electrodes are, of course, gradually consumed. In the two-electrode furnace the renewal of one or the other of these electrodes involves the shutting down of the furnace. On the other hand, the power of the furnace is also limited by the necessity of restricting the dimensions of the electrodes within limits possible of manufacture. However, by the use of several electrodes in parallel, upon the same pole, these difficulties are obviated, and the power of the furnace may be practically unlimited. In this latter type the renewal of electrodes can take place without interruption of the operation, as during the removal of a single electrode the circuit remains closed through the others of the same polarity. These improvements made possible the use of the electrical blast furnace now employed by Keller, Leleux & Co.

In the English language a new name seems necessary to properly describe this type, for while it is similar in appearance and operation to the ordinary blast furnace, there is no "blast." The French *haut-fourneau*, of course, can be applied to either type.

PROCESS OF MANUFACTURE.

In that which concerns the process of manufacture M. Keller began by employing one and the same apparatus for the reduction of the ore and its subsequent conversion into steel. The steel thus obtained was of good quality, but the operation, while permitting of the production of the desired quality of metal, was not practical and commercial from the modern metallurgical standpoint. The production of a predetermined quality of steel, starting from the raw minerals, carried on in the same apparatus, necessitated a series of successive steps (reduction of the ore, purifying, and refining) which required somewhat different conditions of operation, and in consequence careful and constant supervision. In reality, during the period of reduction the furnace is operated full of materials, the refining and purification only being undertaken after the mass has been reduced to a molten condition. In order to be entirely satisfactory for reduction or smelting purposes the furnace should be capable of accommodating a considerable quantity of materials to be treated, in which case it would not be conveniently arranged for the later steps of refining. This latter operation really requires a rather shallow furnace body and that the metal should be in a state of extreme fluidity and easily accessible. These inconveniences suggested the adoption, in the process of making steel by this means, of two electric furnaces arranged *en cascade*, the upper furnace being intended and constructed especially for the reduction of the ores, while the lower furnace would be specially designed and exclusively reserved for the refining and purification of the rough cast metal from the upper furnace. By this method each part of the apparatus has its own special function; the superior furnace remaining always full of materials, the metal being cast at regular intervals, likewise the slag, at the tap holes arranged for these operations. The lower, or inferior, furnace thus contains only the liquid metal and the materials added for refining and purification. This method practically constitutes the Keller process, as applied at the company's works at Kerrousse. The process is carried on by means of a blast furnace of 375 horse power, electric, of which the following is a more detailed description.

ELECTRIC BLAST FURNACE.

As previously explained, the French term *haut-fourneau*, or high furnace, can hardly be rendered into English, except as "blast furnace" or cupola. The Keller electric blast furnace is really two furnaces arranged *en cascade*, as described. The upper furnace contains two groups, each consisting of two electrodes placed vertically, the two electrodes of one group being in parallel, and the two groups themselves are connected in series. These four electrodes are placed in the same cavity, which forms the receptable for the molten metal, this being lined with refractory material. The floor of the furnace is inclined toward the casting hole; the bottom is made in the same manner as the bottoms of the open-hearth furnaces. The fusion chamber of the furnace is surmounted by a column of masonry, and into the shaft thus formed are fed the ores, the carbon for reduction, and the fluxes, which are charged at the top. Immediately beneath the casting hole of the upper furnace the lower or refining furnace is placed; this latter furnace consisting of a chamber with refractory lining, serving simply as a receptacle for the cast metal. Into this receiving vessel, which can be closed by removable covers of refractory material, two vertical electrodes are placed, which can be raised or lowered by means of mechanism operated by hand.

At the commencement of operations the upper furnace is filled with materials, introduced at the top of the shaft until the same is filled up. The separate zones of high temperature at the end of each of the four electrodes are regulated separately by watching the four ampere meters and two voltmeters put into circuit for the purpose; this regulation can be accomplished readily several minutes after commencing. The fusion of the ores and reduction of the metal commences at the bottom. After a little while the carbonic oxide and the ores contained in the furnace shaft are sufficiently heated to commence the reaction. From thenceforward the reduction takes place, not only in the lower part of the furnace—that is to say, in the zone of high temperature—but also throughout the column of material in the shaft, which is kept filled up. The gases which reach the upper part of the furnace are conducted into a suitable chamber and there burned, the heat being used for drying material to be fed into the furnace. After several hours of operation a cast of the metal is made into the lower or refining furnace, previously heated, and already containing materials in a state of fusion. When the cast metal has been poured from the upper furnace down to the slag the sealing plug is introduced in the ordinary manner. The electric current is then suitably regulated in the lower furnace, which has just received the cast metal, in order to keep it at a high temperature, ready for commencing the decarburizing.

At the time of casting from the upper furnace the materials sink down in the charging shaft. The electrodes, which had been slightly raised for regulation of the tension, are lowered and returned to their initial position. Fresh materials are then introduced at the top.

After a certain period of operation the slag of the upper furnace is discharged by means of an opening through the side of the furnace placed for the purpose. The casts of metal and discharge of slag are effected at regular intervals during the period of operation, and the whole working of the system is regulated in the ordinary manner by examination of the slag and cast metal. It is thus possible to obtain a cast metal of uniform composition, making easier the next step of refining the metal and arriving at a uniform method of doing so.

The two furnaces receive their electric energy from the two alternators installed.

When the lower furnace has received a sufficient quantity of molten metal the process of refining it is begun. In a plant of some size, specially installed for this work, two refining furnaces could be arranged to receive electric current from the same generator. In the refining furnace the electric current is so regulated as to obtain a complete liquefaction and rapid reaction of the metal with the refining and purifying materials introduced.

We have seen the rough metal decarburized by the well-known method of introducing an oxide into the metallic bath, the oxide being the iron ore itself. We have also seen the decarburization effected by the addition of scrap iron, which was plunged into the fused metal, between the electrodes. The purification is effected by a suitable addition of lime.

The stopping point of the decarburizing and purifying processes is determined by a mechanical examination of samples taken, as in ordinary metallurgy. After the final additions, which, however, are common to all methods, and not particularly associated with the electric furnace, the casting is effected following a strong heating. The metal is run out into a pouring ladle and thence distributed in the ordinary fashion into ingot molds. Soon after the cast the electric current of the lower furnace is reduced in strength, and the furnace is ready to receive a further quantity of metal from the superior furnace, and so on. Operations thus conducted are continuous, because the method of grouping the electrodes in the upper furnace permits of their renewal without interruption of the reduction process.

M. Keller, who personally directs the manufacture which we have described, stated that in view of the relatively limited quantity of electric power at his disposal at Kerrousse he had not judged it advisable to install certain auxiliary apparatus which he has worked out for the exploitation on a larger scale of his process for the electric manufacture of steels. He assured us, however, that these additional fixtures would permit of the casting and subsequent refining of from 15 to 20 tons of metal at one time, or a larger quantity if desired. We have also been present at one operation where steel was made direct from scrap iron. This operation requires, however, electrical constants different from those employed for the treatment of iron ore itself. A purified fusion was effected in the upper furnace and the refining and purifying carried to the same point in the furnace interior as we have previously described for the direct treatment of the ore. The treatment of scrap iron presents fewer difficulties than that of the ores and requires less electrical energy. In the manufacture of steel which we have followed, either by the treatment of the ore or by treating scrap iron, we have observed that the apparatus employed is simple and practical and permits of regular operation. We have also noted that the efficiency or yield of the apparatus is such as to demonstrate economical results from this process.

NET COST OF MANUFACTURE.

We have verified that the manufacture of 1 ton of steel requires 2,800 kilowatt hours—that is to say, about 3,800 electrical horse power hours. In order to determine the cost of manufacture in the case of treatment direct of the ore we will take as a basis the following prices, which can be obtained ordinarily:

Price for 1 ton of iron ore, 55 per cent. metallic iron, delivered at the factory	$2.00
1 ton of coke for reduction, delivered	8.00
1 ton of flux, delivered	3.00
Price of labor per day	.60
Price per 100 kg. of electrodes, delivered	6.00
Electrical energy per kilowatt year of 8,400 hours	10.00

This last price includes depreciation of the buildings and of the motive machinery. These figures are, of course, based upon costs in France, and would have to be modified to suit local conditions in America. The ton referred to is the metric ton of 2,204 English pounds.

Taking a factory of average importance, the expenses of manufacture of a ton of steel include:

a. Raw materials (ores, coke, electrodes, fluxes, and special products for alloys).

b. Electric power.

c. Maintenance (general repairs, ingot molds, fire brick and refractory materials, tools).

d. Labor.

e. General current expenses.

f. Deterioration of plant, etc.

The total of these costs may be put at about 90 francs ($18) per metric ton.

We may therefore conclude that a ton of steel, manufactured by electrical treatment direct of the iron ores and cast into ingots, not including manufacturing licenses, can be accomplished at about $18 to $20 per metric ton, in round figures. Under exceptional conditions of cheap raw material and electrical energy the net cost could, of course, be diminished.

In the manufacture of steel by treatment of scrap the production of a furnace is much increased with equal expenditure of energy over the treatment of ore direct, and in consequence the electrical energy is a less important item per ton of steel produced than when treating the ore itself. On the other hand, the scrap iron represents a larger item than the combined cost of the coke and iron ore. The advantage of one or the other method will depend, of course, upon the geographical situation of the plant.

QUALITY OF STEEL OBTAINED.

This article would be incomplete if it did not add to the previous questions of economic results something about the quality of the steel obtained. Several ingots of steel of about 120 kg. each were cast in accordance with previously described methods, and these ingots were submitted to metallurgists in the basin of the Loire for tests. The best conception of the quality of steel can probably be obtained from the report which follows:

"Working Qualities.—The metal was worked *au naturel*—that is to say, as received and without any tempering whatever; it behaved perfectly under the hammer, forging easily at an average temperature of 900 deg. C. about. Under these conditions it bent well, proved to be soft and workable with remarkable facility.

"A portion of the ingot having been forged and hammered without showing any faults, a strip about 5 or 6 mm. thick and 12 cm. wide was pierced while at red heat, close to its ends, by means of punches of various diameters. The fourth hole thus punched left a very narrow margin of metal at the sides, but still it did not show any alteration.

"The same portion of the ingot cut into two pieces showed a very clean fracture, denoting good quality steel.

"Another piece was then heated to a temperature of 1,250 to 1,300 deg. C. and showed that the metal did not stand the heat; it would not work well at this temperature, even 1,000 deg. being somewhat too high, and above that point the metal burned.

"Mechanical Tests.—The ingot having been reheated to 900 deg. C., a piece 80 x 80 mm. was forged into a round bar, for tensile test pieces of 500 mm. length and about 30 to 32 mm. diameter. This was accomplished with but one heating and very easily, demonstrating that the metal was exceedingly pliant.

"Up to this time we had been of the opinion that this was a soft steel, but this test showed to the contrary; in fact, the metal cooled slowly during the operation and was found to possess the rather curious property of becoming excessively hard at about 500 deg. C., while it worked freely at 600 to 650 deg. C.

"In order to determine the hardness we attempted to cut while cold a small piece from the test bar, but the tool was dulled without penetrating very deeply, and in order to detach the piece the bar had to be reheated.

"Chisel tests upon the small piece thus taken confirmed its great hardness.

"Tests for bending and rebending while hot upon strips of various widths and thicknesses gave very good results; the pieces were bent flat upon themselves and then rebent, without showing signs of fatigue.

"Similar hot bending tests were made transversely with equally good results.

"These tests permit us to state that the metal has considerable spring and lead us to think that the limit of elasticity should also be high.

"Following is a memorandum of the chief of tests, indicating the results as to resistance and elongation of a test piece reheated to about 900 deg. C., this test piece having been reforged and reheated before turning:

Diameter of test piece	13.8 mm.
Length	100 mm.
Tensile strength per square millimeter (118,000 pounds per square inch)	83.4 kg.
Elongation	13 per cent."

From the above report it will be seen that the quality of steel obtained by means of the electric furnace will be found satisfactory to the metallurgist, and that the electrically made steels can enter into competition with the open hearth and Bessemer products. We are convinced that electric steels should compete successfully with crucible steels, for the reason that in the process of refining electrically the heat produced does not furnish a source of oxygen; the electric steels are thus likely to contain dissolved oxides of iron, and can therefore easily reach the quality of crucible steels. Moreover, the manufacture of steel by the electric furnace possesses, as compared with the crucible process, the considerable advantage that it may be undertaken upon a much larger scale, and it is almost certain that very soon the small crucibles, containing about 30 kg. of steel, as now employed in many steel works, will be replaced by the larger electrical crucibles, containing several thousands of kilogrammes of metal.

The Cie. Electro-Thermique Keller, Leleux & Cie., in view of the results above described, and understanding that this question is pregnant with possibilities, have decided to install apparatus of much greater power than that now at their disposal, in order to be prepared to show within several months, a steel works of considerable capacity in operation, with a view to granting licenses and furnishing apparatus for their processes.

Without going so far as Zola, who, in his last romance, "Travail," pictured to us the struggle between the heavy *haut-forneau* and a light battery of electric furnaces, and after showing us the last cast from the *haut-forneau* and the "Death of the Monster," decisively vanquished by the electric furnace, we are disposed to think that the electro-metallurgy of iron will very quickly assume an important position and be generally adopted in places where *la houille blanche* has the mastery over *la houille noire*.

Having mentioned some improvements which M. Keller has designed in connection with his system of furnaces, it might not be out of place to explain briefly two of particular interest. One is an arrangement whereby the refining furnace is mounted upon a truck running upon rails, so as to be movable backward and forward in front of a battery of electric blast furnaces, thus serving the whole battery. By this plan the refining furnace really becomes a huge ladle of special design, which can be moved quickly into position at any of the reducing furnaces ready to cast. After the metal has been run the refining furnace is then placed underneath the electrodes, which are inserted, current turned on, and the process of refining carried

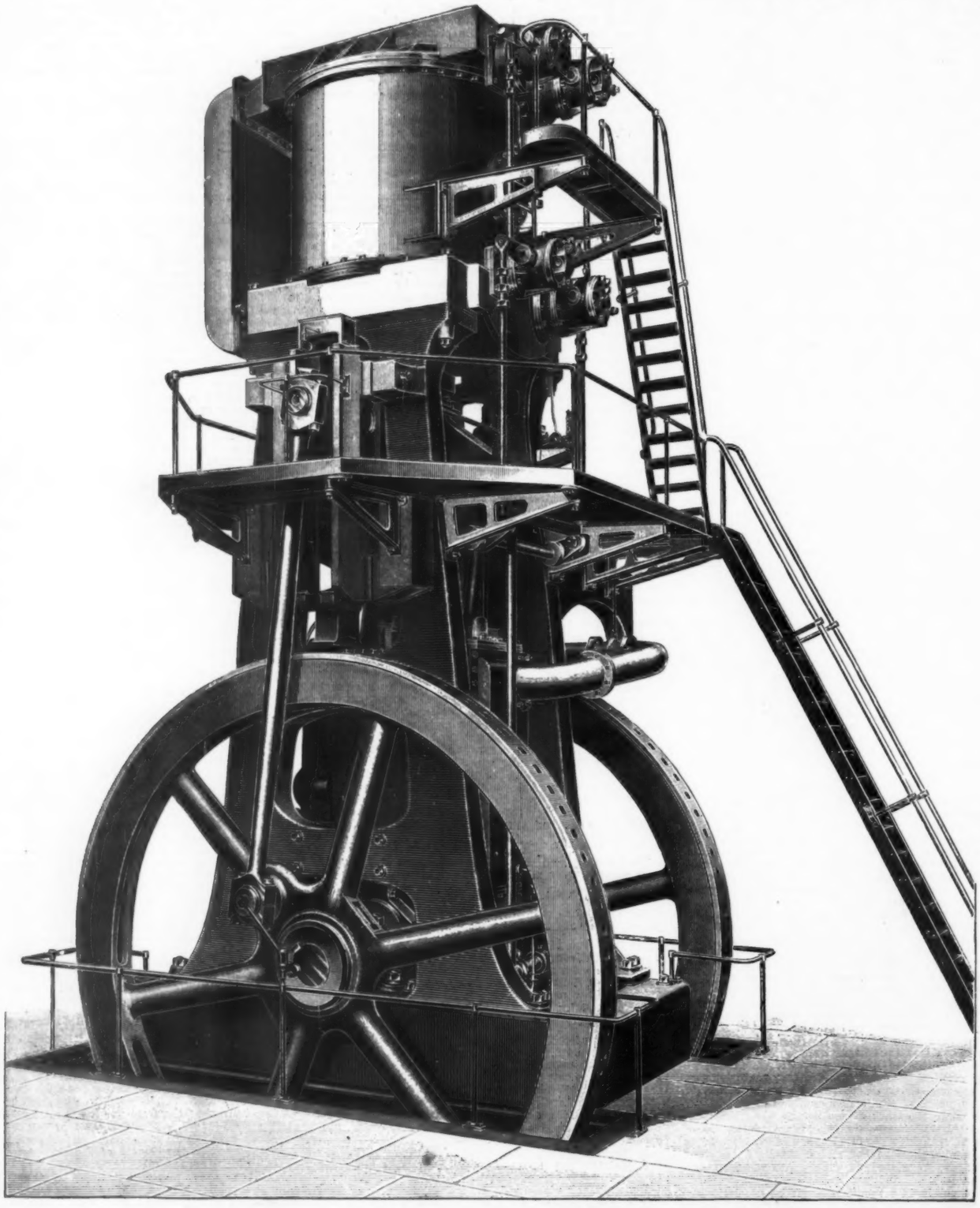
out. In this way the refining furnace is in almost constant service, introducing a considerable factor of economy into the process. Now that the utilization of blast furnace gases is a live question, it is not a far step from their use to drive gas motors, electric generators, etc., to the usage of the electric current for refining cast iron at the blast furnace itself and producing good quality steel. Surely this must be an alluring prospect for some of our enterprising American blast furnace operators.

Another improvement is an arrangement whereby the refining furnace is operated in conjunction with the ordinary foundry cupola. This plan also presents possibilities to American founders in localities where electric power may be had at reasonable figures.

Indeed, its application need by no means be confined to places having hydraulic installations, and this very question might be found an interesting and profitable one for combined study by our foundries and electric light people. An arrangement whereby the current could be supplied to founders for the conversion of cast iron into steel during the periods of light load at electric light stations might help to solve the vexed question of taking off the peak of the load curve by the satisfactory method of moving the rest of the curve up to the peak. Under such conditions power could doubtless be supplied at prices which would pay founders and light companies.

BLOWING ENGINE.

THE illustration herewith shows a single unit blowing engine, built by Galloways, Limited, of Manchester; two similar engines are just now being put into work by the Carnforth Hematite Iron Company. These form another stage in the development which has been taking place recently in blast furnace practice in this country. Air pressures of from 4 pounds to 6 pounds are being superseded by higher pressures for working the American type of furnace, which demands at times pressures as great as 20 pounds per square inch. The whole of the general structure and details have been designed to meet these conditions. Each engine is capable of delivering about 20,000 cubic feet of free air per minute, reckoned from atmospheric pressure, when running at fifty-three revolutions per minute. As will be seen, the engine is of the vertical type, consisting of a heavy bed-plate, on which rest the main standards or housings, between which is carried the steam cylinder, with the air cylinder directly above it, and on top of the columns; the steam piston rod is coupled direct to the cottering block, to which is attached the piston-rod of the air cylinder. The cottering block is of cast steel, and to it is connected a long crosshead by means of a stout pin at right angles to its main axis. From the ends of this crosshead depend connecting-rods, one on each side of the engine, which drive the shaft through pins in the flywheel. By this construction the swiveling action is obtained which distributes the load to the shaft in a perfectly even manner. The bed-plate is a heavy casting of box section, planed to receive the standards, etc., and the two heavy pedestals for the main bearings. The standards are also of box section, having four substantial slide bars arranged thereon, and fitted with a large slide block provided with means for adjustment. The diameter of the steam cylinder is 44 inches. It has four grid-valves, two for steam, and two for exhaust, the former being under the control of a powerful high-speed governor operating through an expansion link, and arranged so that the speed of the engine can be regulated between very wide limits, as is demanded for blast furnace working, and controlled to suit the pressure of air.—Engineer.



VERTICAL BLOWING ENGINE.

The London Colliery Guardian says in North Staffordshire iron ore was smelted at Uttoxeter early in the thirteenth century, and coal and red ironstone were both dug at Amblecote in the reign of Edward III. In a deed of the Heronville family, of 1315, some lands bequeathed to Johannes de Weddesbyrie, are described as lying at Bradeswall, "over against the cole

pits." A deed of the Perrye family, dated 1401, mentions a piece of land with "ye two cole-pits thereon situate, called ye Hollowaye and ye Delves, situate neare Windmill Field in Bylstone." Some curious particulars of this ancient pit are given in a local history written by G. T. Lawley. It was, he says, worked by William Tomkys, Thomas Jacson, and Nycolas Foxhall. Their first shaft was square in shape, supported on the sides by scantling timber. The coal was raised by a common windlass. This pit was worked until the seventeenth century, and was visited by Dr. Plot, the county historian, in the year 1640. In the year 1490, a coal pit was in successful operation at Moorfields, near Wolverhampton.

GERMAN METHOD OF DRYING WOOD.

IT is generally supposed that wood which has been for some length of time in a drying room, exposed to a heat of from 50 deg. to 60 deg. C. (122 deg. to 140 deg. F.), is perfectly dry and fit for use without there being any fear that it will shrink, split, or bend; but this supposition is not always correct, as even an expert woodworker may be mistaken as to whether it is perfectly dry or not, unless he knows the exact treatment the wood has received from the time when it was felled in the forest until it left the drying room.

So far it is a little known fact that wood which has been floated in rafts or otherwise gives a more reliable joinery and building material than that which has been carried by cart or rail to the sawmill and workshop. While the wood is lying in the water its sap and albuminous and salty substances are—owing to the diffusing effect exercised by the water—dissolved and come out of the pores, the water taking their places. This dissolving process, quite similar to that which takes place during the manufacture of sugar out of cane or beets, will progress more slowly at the ordinary temperature of river water—i. e., at from 12 deg. to 18 deg. C. (52 deg. to 65 deg. F.) than it would at a higher temperature, but the length of time rafts in Germany usually spend on their journey down rivers is entirely sufficient for this process to take place, even at an unfavorable temperature.

The salts and other substances in the wood, like albumen and wood gum, are hygroscopic—i. e., they eagerly absorb the dampness in the atmosphere, so that apparently wood which has been kept in dry drying rooms for a sufficient length of time is apt to become damp again in the open air unless it has, when floating down the river, gone through the above-mentioned diffusing or washing-out process.

With the better qualities of wood a secretion of the hygroscopic substances is brought about artificially in our local drying establishments with the help of a special apparatus. The boards or planks are piled up in a long iron box, with narrow spaces between; the lid is then tightly screwed down, so that neither water nor steam can escape. Steam is then turned into the box at a continuous pressure of 0.2 or 0.3 atmosphere, and this process is continued for from sixty to seventy-two hours, the exact length of time being determined by the hardness and density of the wood. The steam opens up the wood and kills the protoplasm which is still alive in the cells. After having been thus prepared the wood goes into a water bath, where it is kept for about a fortnight.

The drying process, as practised here, is about as follows: The boards are loaded on a small cart, leaving small spaces between them by placing narrow strips in position. The cart is then pushed into the first drying room. The size of these rooms differs a good deal; they are mostly from 20 to 30 meters (66.45 to 84.25 feet) long, with breadth and height to correspond. The temperature is kept between 50 deg. and 60 deg. C. (122 deg. and 140 deg. F.). Steam or hot water pipes, placed on one side and underneath the flooring, supply the necessary heat, fresh air being admitted from one side by openings which can be wholly or partially closed by means of slides. At times, when the fresh air does not enter fast enough, exhausters and ventilators are employed. The air, after becoming heated and passing between the layers of wood, becomes saturated with its moisture and is then forced out at the other side of the room by numerous openings, or a long slit connected with the outer air by openings leading to the roof.

In most establishments the wood, after having been in the first heating room for a sufficient length of time, is taken right into the workshop. This, however, is not the best method; it is better to have the first drying process followed by a second one in another drying room, which is heated by means of a stove extending its whole breadth, provided with fuel—usually coke—from the outside. The process is then about the following: Each board or plank that comes from drying room No. 1 is given an exact rectangular shape at one end; it is then loaded on a cart and put into the second drying room, after which the door is closed and any loose places that may become noticeable are filled up with mortar. The fire is then started and brought to a red heat, plenty of air being allowed to pass over the fuel, while the smoke is carried off by regulating outlets, which are provided underneath and beside the cart. After from fifty to sixty hours the cart is taken out and each piece of wood carefully examined as to whether it has kept the exact rectangular shape with which it was provided before being put into the heating room. Those pieces which have kept their shape may be considered as quite dry and ready for use, while the others will be once more cut rectangular at one end and put again into heating room No. 2. On being withdrawn, after about twelve or eighteen hours, every angle is as it should be—consequently, quite dry and in perfect condition for use. Many manufacturers are afraid of the expense and loss of time in connection with this double-drying process as described above, and so they use wood which has been less carefully treated. The natural consequence of this omission is that furniture, etc., manufactured by them will split or bend very soon after having been put to use.

Finally, it must not be forgotten that wood which before being dried has been floated, and thus gone through the wash-out (Auslaugung) process referred to at the beginning of this article, makes very useful timber, as it is less liable than non-floated wood to be attacked by micro-organisms, the reason for this being that the washed-out (ausgelaugte) wood consists almost exclusively of cellulose and liquose, on neither of which do mold nor bacteria thrive. Such timber will require but a slight saturation with an antiseptic solution to become safe from putrefaction and destruction through fungi.

DANGER FROM ELECTRIC SHOCK.

CASES of fatal electric shock are, fortunately, of rare occurrence, and are mostly confined to those employed in the generation and distribution of electricity. It is difficult to ascertain the minimum strength of current which is dangerous to life, as there is so much variation in the effect according to the circumstances attending the shock. Currents of 30 to 40 milli-amperes are probably as much as can be borne without great discomfort, although we find it stated that for medical purposes, and, of course, with due precautions, as many as 200 milli-amperes can be safely passed through the human body. The effect is, however, modified so much by the state of health of the individual, by the length of time during which shock has been inflicted, and by the path which the current has taken through the body, that no definite safe limit can be positively laid down.

As a general rule, the resistance of the human body is normally so high that with pressures not exceeding 500 volts accidental contacts are rarely fatal shocks, although occasionally the portions of the body on which contact is made are severely burnt. The few fatal accidents which have occurred at low pressures appear to have been attended by a body resistance far below that usually met with. The effect of a shock may also be to cause such muscular contractions that the victim is unable to let go of the conductor which he has grasped, and, if help is not at hand, death may result from the prolonged application of a current which, if it had been only momentary, might have been comparatively harmless. On the other hand, there are on record cases of shock at pressures of several thousands of volts in which death has not resulted.

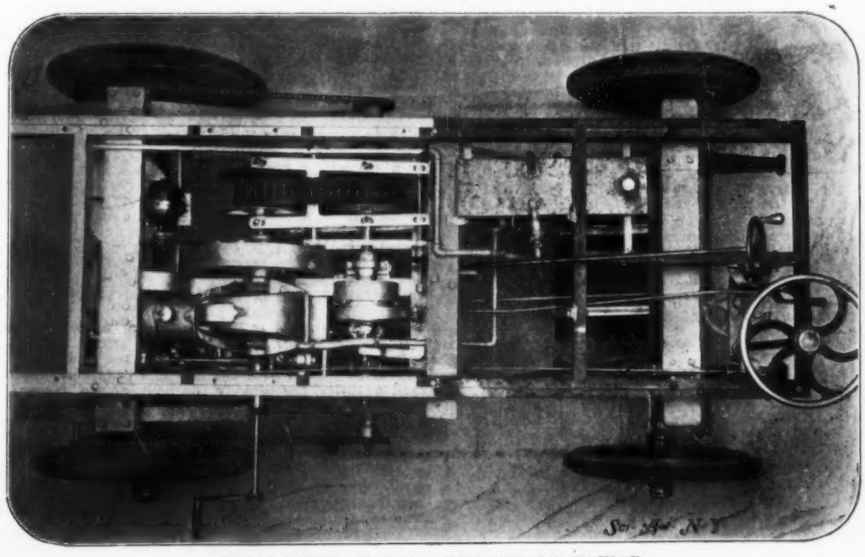
The ultimate cause of death, when due primarily to electric shock, is generally considered to be stoppage of the action of the heart or of the respiratory organs. That the latter may be affected is shown by the fact that victims of electric shock are sometimes brought to by practice of some of the well-known methods of artificial respiration. The cessation of the heart's action may be due to stimulation of the nerves which control the beating of the heart; these, when stimulated to excess, may cause the heart to stop altogether.—Archibald Wilson, in Cassier's Magazine.

AN AUTOMOBILE RAILWAY TROLLEY TOWER WAGON.*

ONE of the most recent applications of the automobile to the needs of everyday life is that of providing a more efficient means for repairing trolley-wires. A vehicle especially adapted for this purpose is made by the Motor Truck and Vehicle Company, Columbus, Ohio, and is illustrated in the accompanying engravings. One of our views shows the tower wagon ready for use; the other represents the wagon in plan.

THE AUTOMOBILE TROLLEY TOWER SET UP FOR USE.

Power is furnished by a single-cylinder, four-cycle water-cooled gasoline engine, and is transmitted by means of a special variable speed transmission to a friction clutch. From the friction clutch the power is transmitted to a compensating gear located on a jack-shaft, from each end of which chains run to the rear wheels. By reason of this arrangement it becomes possible to use a solid rear axle which, for a vehicle of this weight, gives a more substantial and rigid frame than would otherwise be obtained. Apart from this very rigid construction, one of the particular features of the automobile is its variable speed transmission by means of which the speed can be varied from the maximum to the minimum rate, not by jumping from one fixed speed to another, but by a gradual variation which renders it possible to reach any point between the two rates.



PLAN VIEW OF THE AUTOMOBILE TOWER.

The chief advantage of this machine over the horse-drawn trolley wagon which it is designed to supplant,

* Specially prepared for the SCIENTIFIC AMERICAN SUPPLEMENT.

is primarily economy of operation, which is, indeed, a distinctive feature of all commercial vehicles when compared with the corresponding horse-drawn types. Furthermore, the machine can be run in all kinds of weather, from the extreme heat of summer to the slippery cold weather of winter. The difficulty of satisfactorily operating horse-drawn vehicles in very hot or very cold weather need not here be dwelt upon. When working on a trolley it is a simple matter to pull the automobile trolley tower to one side, to let the cars pass, and to back the machine to its working position again with very little delay. The maneuvers of a horse-drawn wagon are far more complicated. It is necessary to draw the wagon from the track and then turn it around entirely in order that it may regain its original position.

It is unnecessary to describe the tower used, for it is of the kind with which railway men the country over are familiar.

[Continued from SUPPLEMENT No. 1432, page 22944.]

THE SERPOLLET STEAM AUTOMOBILE.*

IV. THE BURNER.

THE water and gasoline tanks of the 12 horse power Serpollet surrey are situated, the one in front so as to be near the condenser, and the other under the forward seat. The water and gasoline systems run parallel to each other to the back of the carriage, where are located the burner and generator, as shown in Fig. 1. The burner consists, in reality, simply of 12 or 18 Bunsen burners (according to the size of the car) mounted on a bronze pipe casting. The spraying nozzles, or burners (Fig. 5), are screwed into holes in the top of the pipes, located at the joints and ends of the same. The ends of the pipes are fitted with screw plugs, *m*, intended to be removed once every 1,800 miles for the purpose of allowing the tubes to be cleansed of any carbon deposit that may form within them.

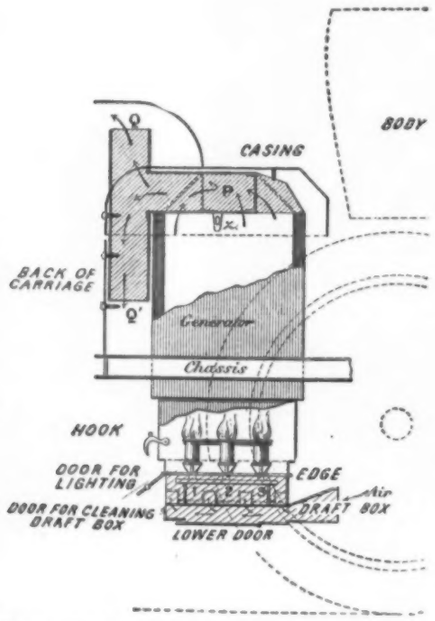


FIG. 1.—DIAGRAM OF BURNER AND GENERATOR AS MOUNTED ON BACK OF CARRIAGE.

Each burner tip is screwed into the pipe casting, and packed with asbestos and plumbago. It clamps in place a circular frame, over which is slipped the cup shaped cover notched, as shown in Figs. 4 and 5, for receiving the pipe of the vaporizing coil, *B*. The vaporized gasoline escaping rapidly through a small hole in the burner tip, causes a violent rush of oxygen through the interior of the hood, and the flame that results bursts from the top of the latter with the vigor of that of a gasoline torch—almost, one might say, with the force of the gas from the exhaust pipe of a gasoline explosive motor.

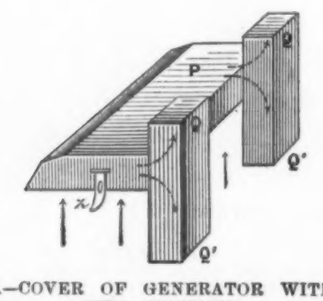


FIG. 2.—COVER OF GENERATOR WITH ITS TWO CHIMNEYS.

It will readily be seen that twelve or eighteen burners of this power, concentrating their heat, will rapidly raise the generator upon which their flames impinge to a very high temperature. Besides generating steam, the heat of the burners is used to vaporize the gasoline which supplies them. This enters at *A* (Figs. 4 and 5) the vaporizing coil that is wired down with chains, *C C*, in the notches of the burner hoods; and, after being thoroughly vaporized, it enters the burner casting at *B B*, whence it spreads through the different passages and makes its exit through the several tips in the form of gas.

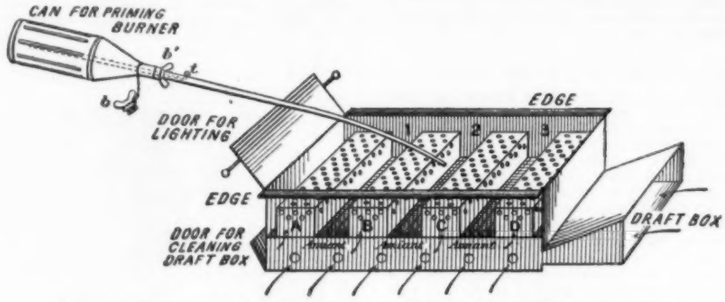


FIG. 3.—BOTTOM OF BURNER BOX WITH BURNERS REMOVED.

The burner casting has a chamber, *M* (Fig. 4), closed by a plug, and in this chamber is placed a roll of wire gauze tightly wrapped around a loop of wire, which can be caught by a small hook and withdrawn when it is necessary to remove the gauze and clean it. This should be done about once in 300 miles, in order that the strainer shall not become too greatly filled with particles of carbon.

The burner rests on four legs in a sheet iron box, *P* (Fig. 5), the object of which is to support the burner, to assist in lighting it, to protect it from mud and dust, and to facilitate the drawing in of air, of which it requires a plentiful supply for maintaining proper combustion. The air box at the bottom (Fig. 1), is provided with a wide mouth in order to increase the draft, which is further assured by the tightness of the casing surrounding the generator and to which the burner is attached, as well as by a pair of double chimneys, *Q Q'*, on top of and behind the generator. The double chimney effectually counteracts all trouble from gusts of wind, for, as the wind encounters no obstacle, it can blow right through from *Q* to *Q'*, or *vice versa*, without crowding back the gases of combustion. Although the arrangement appears simple, it was only perfected after numerous trials and experiments, by which the best length and location of the vertical chimney was arrived at. The generator top is fastened in place by two catches, *z*.

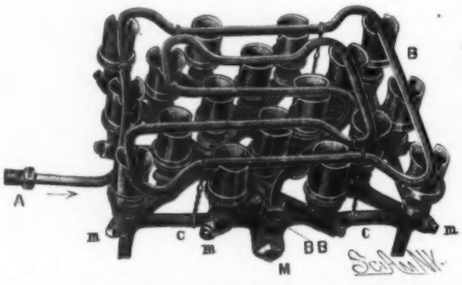


FIG. 4.—BURNERS ASSEMBLED ON BURNER PIPE CASTING, SHOWING VAPORIZING COIL ON TOP.

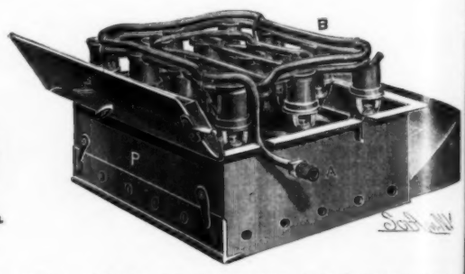


FIG. 5.—VIEW OF BURNERS COMPLETE AND MOUNTED IN THEIR BOX.

The burner is first started by means of alcohol, which is spread over three layers of asbestos, 1, 2, 3 (Fig. 3), with a long-necked squirt can. This can has a special air vent pipe shown in dotted lines terminating at *t*; the spout can be removed and the cap substituted for it for convenience in carrying. To start the burner, the asbestos strips are well soaked with alcohol, care being taken not to pour the fluid on the perforated partitions, *A, B, C, D*, opening into the air box, as then it would be wasted. After the three asbestos pads have been thoroughly saturated with about a tumblerful of alcohol, this is lighted with a match, and the door is closed.

While the alcohol is burning, the driver makes the final preparations. Then, in about two minutes, he again opens the door of the burner box and pours a little more alcohol over the asbestos pads; but a very small quantity, for already the body of the burner is warm, and the alcohol vaporizes almost immediately upon coming in contact with the asbestos. More of the alcohol should be poured near the door than at the back of the burner box, for, at the moment of lighting, the burners near the door are always the least warm. For the same reason, also, it is necessary to keep the door closed in order to keep gusts of cold air away from the burners.

The operator should in like manner renew the alcohol four or five times, sprinkling on each time a smaller amount. To pour on a lot of alcohol is not the secret of properly starting the burners. It is best, on the contrary, to use but little, but to spread this little well, and let the quantities of liquid distributed produce their entire effect. Five minutes and ¾ pint are sufficient for lighting one of the larger 18-tip burners.

As soon as the burner is sufficiently hot to vaporize the gasoline that is coming to it, pressure is put on the gasoline in the tank by means of the hand pump, *P* (Fig. 6), beside the seat, and the valve, *D*, in the pipe line from the tank to the burner is opened. The vaporized gasoline then issues from the burner tips and is ignited by the dying-out alcohol flame. Thus the burner is started.

If the burner has been properly started, no smoke will be emitted from the two chimneys. The smoke is always due to some of the gasoline not being thoroughly vaporized. This may happen from the following causes:

Because some of the burners are not thoroughly warm and the gasoline, entering them, cools them still more and burns with a smoky flame.

Or because a burner is partially stopped up, causing the gasoline to trickle down around it.

Or because the joint between the tip and the burner casting is not tight and the gasoline leaks.

Or, finally, because the pressure put upon the gasoline in the tank is too great, and the quantity of liquid forced through is too large for the calorific state of the burner. It is only necessary to give a few strokes of the pump when starting, so as to raise the pressure to scarcely 50 grammes per square centimeter in order to allow the flames to thoroughly heat the burner and thus get in condition to stand quantities of fuel at 1,500 and even 2,000 grammes pressure when, the vehicle being under way, the automatic pump is aspiring and forcing it into the tips.

If, therefore, the burner should smoke abundantly at the moment of lighting, due probably to its being insufficiently heated, it would be preferable to close the cock, *D*, in order to stop the flow of fuel, and then sprinkle some more alcohol in the starting box. To keep on running the burner if it smokes, will choke it up and cause to deposit, on the burner tips and on the generator, lampblack, a substance which is a very poor conductor of heat and therefore harmful to the best efficiency of the machine.

If one or two of the burner tips are choked up, open the door and clean them out with the small wire furnished for that purpose. All that is necessary is to insert the wire in the capillary orifice and withdraw it. When all is in order—and all is in order when one does not hurry the operation with harmful haste—close the door of the burner carefully. I insist on this detail, for often one forgets to close again this door, with the result, at first, that the heat lessens and, secondly—a more disagreeable result—that the burner box, which is held in place on slides on the bottom of the generator by two hooks, slips off and falls to the ground with its contents. The burner, attached to the vehicle by the gasoline feed pipe, is then dragged some yards in the dust, till the pipe breaks.

Of the four pressure gages seen on the dashboard (Fig. 6), the one on the right, *A*, which shows the pressure in the gasoline tank set up by the hand pump, *P*, indicates the pressure in hectogrammes, while the other three indicate the pressure in kilogrammes. The pressure in the gasoline tank is slight and is only used to force fuel to the burner in starting it, during stops, or when coasting down hill—in other words, when but a slight fire is needed to keep up steam.

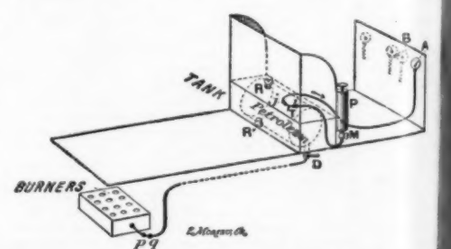


FIG. 6.—DIAGRAM OF PIPING FROM GASOLINE TANK TO BURNERS.

The pump, *P*, has already been described in the previous article; *p q* indicate the joint of the burner, and *j i* couplings in the gage and air pump piping.

* Specially prepared for the SCIENTIFIC AMERICAN SUPPLEMENT from a description by Mons. L. Baudry de Saunier in La Locomotion.

THE APPLICATION OF KELVIN'S THEORY OF THE ETHER TO THE STELLAR UNIVERSE.

By J. R. COLLINS, Secretary Royal Astronomical Society of Canada.

AMONG the problems of interest to, and immediately connected with, physical astronomy, is the problem of the nature and constitution of the medium occupying interplanetary and inter-stellar space. That this medium differs essentially from any material with which we are acquainted becomes apparent from the fact that the planets and other celestial bodies suffer no apparent retardation in their motions during recorded time, though they move through it with velocities from—in the case of the moon—about one-half mile per second, the earth 18 miles per second, Venus 21½, and Mercury 29½ miles per second. From certain optical effects, light and radiant heat are known to travel to us from celestial and terrestrial sources with a velocity of 186,000 miles per second, and to be a vibratory or wave motion undulating transversely to the line of propagation.

When a cord is stretched between two points and one end is jerked or made to vibrate, a wave motion or undulation will travel along its length from the source of disturbance with a velocity varying as the tension on the cord. As the tension is increased, the wave moves faster. The velocity of this motion is, however, only a few feet a second. Vibratory motions in a gas, as air, travel as sound at the rate of a little more than 1,100 feet per second for air at normal temperature and density; when the air is light and rarefied, as at high mountain elevations, the velocity is less than this, and when the air is denser, as at sea level, and saturated with moisture, the velocity of sound vibrations is greater than the amount named. The vibrations that take place in a gas are essentially different from the waves traveling along a cord. Certain experiments in acoustics show the nature of the disturbance in air to be a to-and-fro motion directly in the line of propagation. This seems to be the only regular vibratory motion possible to transmit through a gas.

Liquids, however, are capable of transmitting transverse vibrations, and with a velocity exceeding that of air, quickening as the density of the liquid increases and moving faster yet in a solid, till, in the strongest and most elastic steel, a velocity of several miles per second is attained, of vibrations of a transverse character. But this rate of speed is as a snail's pace compared to the known velocity of light, 186,000 miles per second.

The velocity of transmission increases in proportion as the density and rigidity or elasticity in the transmitting medium increase, and if we increase these properties still further from where steel leaves off until we get a density and elasticity proportionally great enough to transmit vibrations that will come to us as rapidly as light, it will be necessary, as Clerk-Maxwell says, to suppose we are dealing with a medium capable of sustaining strains and stresses thousands of times greater than the strongest steel can support. Electric, magnetic, Hertzian waves, as well as radiant heat and light, have been shown to be disturbances of the ether traveling with the same velocity and possessing ethereal characteristics in common, accompanied possibly with a rotary as well as a vibratory motion. Some of these forms of wave motion penetrate matter of all descriptions, exhibiting modes of motion, there is every reason for believing, impossible for matter alone to convey. Nearly all these forms of energy can be transmitted through the air. Light, magnetism, and Hertzian waves penetrate glass, water, and other transparent substances. Magnetic and Hertzian waves, most of us have observed, penetrate brick walls and the solid rock without appreciable resistance. Dr. Chant, of Toronto University, demonstrated this before the Toronto Astronomical Society in 1895, when he caused Hertzian waves to penetrate the thick walls of the physical lecture room of the university, by apparatus constructed by himself after a model of Hertz. With the facts, thus stated, in view, there seems to be no escape from the conclusion that there is a subtle, imponderable substance that not only fills the interplanetary and inter-stellar spaces, but saturates all material things, penetrating intermolecular and interatomic spaces, and possibly the very body of the atom as well.

The ancient Greek philosophers recognized the necessity of an ether of some kind to help them untangle their metaphysical speculations in regard to the manifestations of the cosmos, but their concepts of it seem to have been rather hazy and ill-defined. From the first the favorite view was to regard the ether as attenuated air composed of exceedingly small particles that were bandied about in all directions; but as empirical physical investigations developed, this view of the ether became so involved as to become a clog on the wheels of progress, ethers upon ethers each differing from the other were called in to explain the physical difficulties that persisted in presenting themselves for solution. No one kind of ether was thought capable of explaining everything, but separate ethers were thought essential for differing phenomena. The caloric ether was invented to explain the phenomena of light. Each material object capable of being heated and of emitting light was thought to have the capacity for secreting or manufacturing an inexhaustible supply of small imponderable particles which were shot out in straight lines in every direction by the agitation of the heat, which was thought to be another kind of ether. Magnetic effluvia or atmosphere was another kind of ether; and so on with every other manifestation of energy until the number of ethers called into existence became so numerous as to suggest a problem utterly inexplicable.

Newton subscribed to this view of the ether in a general way, apparently only because he could see no way out of the difficulty, though it is hardly necessary to state that his demonstration of the universality of gravitation did more than any other one discovery to clear the way for the concept of the unity of energy operating in the universe, which culminated in the grand generalization of the nineteenth century—the conservation of energy, as demonstrated by Joule in 1867. In the early part of the last century Young's work in connection with optical problems definitely established the correctness of the view advocated by Huygens, that light was a wave disturbance in a medium and not particles shot out from a radiating body. This was shown to be the case from certain interference effects of polarized light. With this established, it became necessary to modify the prevailing conceptions of ether. As physicists became convinced that free particles, such as constitute a gas, were incapable of transmitting a transverse wave motion, the translatory motions of the particles were done away with and the particles themselves were still retained, but were regarded as being at rest relatively to each other, and held in place by some intense attractive force. With this view physical optics made great advances at the hands of McCullough, Meuman, and Cauchy, thus behaving like a solid except by those content with action at a distance or by centers of force. Then a jelly-like substance was hypothecated for the particles to be embedded in, and vibrate. Then it was seen the particles were unnecessary and the jelly-like substance alone remained to act as a vibrating medium. Though a motion of a body 30 miles a second without retardation through a solid seemed a paradox, still the fact remained that rigidity best explained the peculiarities of the vibratory motion observed.

This was the view of the ether entertained by most physicists when Lord Kelvin propounded his frictionless fluid theory.

Helmholtz had made his classical, mathematical investigations into the nature of a frictionless fluid and vortices therein, and was said to have mathematically demonstrated that vortices could not be originated in a frictionless fluid, but if once originated they could not be destroyed. This, however, seems a self-evident fact, as friction is necessary to originate a vortex, and is, too, the cause of its stopping. A vortex in a perfectly frictionless fluid would, therefore, be as indestructible as a hard, indivisible, Lucretian atom.

James Clerk-Maxwell had worked out and placed on a firm basis his (or rather Faraday's) electro-magnetic theory of light, which differed from the elastic solid theory in supposing that while transverse vibrations occurred in the ether, a rotary motion in the medium also occurred. As it was difficult to see how a local rotary motion could take place in a solid, there appeared to be no obstacle in the nature of a fluid for it to behave in this way, and for this reason the concept of a continuous fluid of some sort rapidly came to the fore.

With Helmholtz's work in mind, Kelvin was one day watching the late Prof. Tait experimenting with vortex smoke rings, and suggested that possibly what we regard as atoms of matter may be nothing else than vortices in an all-prevailing continuous frictionless fluid (using the term "fluid" as merely indicative of continuity) or nearly frictionless, endowed with the property of inertia. The rapid rotary motion of the vortices would stiffen them into elastic rigid particles, more than the equivalent of the hard impenetrable Lucretian atom. This theory, though provisionally made, has been found to offer such facilities for explaining so many of the otherwise unsolved problems connected with the behavior of matter and ether that it quickly found favor with such experimental physicists as Balfour Stewart, Tait, Clerk-Maxwell, Lord Rayleigh, Lodge, Preston, and Fitzgerald.

Space—stripped of metaphysical entanglements space may be spoken of as "absolute" and "relative." Space relative may be defined as distance between points; space absolute, as that which would remain if matter and ether were removed; and what would remain? Nothing—void. As void can only be limited by a material or ethereal wall it may be readily imagined as infinite, while the relative space in the universe may be as readily imagined as finite or limited.

The air may be pumped out of a glass jar, but the ether remains, and there is no known way of getting it out; but we may readily imagine this being done, and then what is there left in the jar? The space is still there—an isolated portion of absolute space.

The stars show groupings toward what may be called the equator of the universe and thin out perceptibly toward what may be termed its poles. The trend of opinion among observational astronomers is now to regard the entire visible universe as one system and limited in extent rather than infinite. This point was emphasized by Dr. Isaac Roberts in his address before the Astronomical Section of the British Association a few months ago in Belfast. We will, therefore, assume a limit to the universe and endeavor to apply Kelvin's vortex theory to it in a general way and note some of the startling conclusions reached.

If the universe of ether be considered as being a continuous-elastic single atom approaching a perfect fluid and something like spherical in shape, having definite unbreakable elastic surfaced boundaries, and all the material manifestations termed matter to consist of whirls and bundles of vortices of the ether itself, then if a runaway star were to dash against the internal surface, this surface, being extremely elastic, would hurl back the body with the velocity with which it came. If a man were to attempt to thrust his arm through the boundaried surface he would meet with resistance in comparison to which a stone wall would be soft. Other ether universes might possibly exist in the blank space beyond, but there would be no means of communication, as the ether is the necessary vehicle for transmitting energy in any form. Maxwell, Tait, Larmour, and others have suggested that what we term inertia of bodies may be really due to conditions of the ether and not simply a property of matter *per se* irrespective of ether.

When a ball is thrown from the hand the reason it continues to move after the hand has let go may be due to some connection between energy and the ether. If it were possible to throw the ball through the ether envelope of the universe into the blank space beyond, the ball would instantly stop as soon as it entered space devoid of ether.

Optical considerations show us that if a tangle of vortices could be made to spin sufficiently fast to produce an absolute vacuum in the ether, the surface of ether around it would glisten like silver in the sunlight on account of surface reflection, and if struck with a hammer would offer resistance to the blow greater than steel. Thus it might appear that an isolated piece of nothing may be harder than anything else, though in this case it would be the ether surface that would offer the resistance and not the void within. Among the problems the fluid vortex theory gives promise of explanation might be mentioned atomic elasticity, gravitation, relation of energy and motion, the method of translation of and dissipation or degradation of energy, and atomic ionization.

It was due to Kelvin that the corollary of the great law of the conservation of energy, namely, the dissipation (or degradation) of energy, was emphasized if not discovered. The energy of a system manifests itself when changing from one form to another, and in the process of transformation, though the energy is not lost in the absolute sense, yet a determinate amount is always being degraded or dissipated in the act of transformation, into a form of low grade heat which scatters through the ether; and as one of the fundamental laws of thermo-dynamics requires an absorbing body to be of lower temperature than the absorbed temperature, this degraded energy is unavailable on account of its extremely low temperature for material kinetic association, so that a determinate proportion of the entire available energy of the universe is continually departing from the storehouse without replenishment and being continually dumped into what has been termed the waste-heap of the universe—the amount growing less while the waste-heap increases every day. This fact would seem to indicate that the ether—whatever its ultimate structure may be—is not entirely frictionless. All the forms of energy with which we are acquainted are being gradually dissipated throughout the ether itself. On this point Clerk-Maxwell says: "No theory of the constitution of the ether has as yet been invented which will account for such a system of vortices being maintained for an indefinite time, without their energy being gradually dissipated into that irregular agitation of the medium which in ordinary media is termed heat.

"And this vast homogeneous expanse of isotropic matter is fitted to a medium of physical interaction between distant bodies and to fulfill other physical functions, of which perhaps we have as yet no conception."

We have been speaking about energy, but no entirely satisfactory definition of energy has as yet been given. Some have sought to resolve "energy" into motion and only motion. But that "motion" and "energy" are not equivalent terms, becomes apparent when the fact is noted that the energy of a moving body is always as the square of the velocity, velocity being the rate or amount of motion in time.

That is to say, if a ball were thrown with a velocity double that which it formerly had it will require four-fold energy to do it. If a bullet from a rifle be projected with a velocity double that of the normal velocity four-fold energy will be used upon it.

Now, if motion and energy are one and the same—equivalent terms—twice the motion should be produced by twice the energy.

The extra proportion of energy cannot be concealed in the body by virtue of rotation of its molecular parts nor left behind in the recoil or concealed in the ether, for when checked in its course the projectile or body will give out the amount of energy that has been put into it. It will persist, though only having twice the motion, in overcoming four times the amount of opposition. If V^1 will cause a projectile to penetrate one inch of steel, V^2 will cause it to penetrate four inches of steel; or again, if intercepted V^1 will raise the temperature of one cubic centimeter one degree, V^2 will raise four times that amount one degree in the same time. So that it would appear, whatever energy may be, it cannot be motion only, though motion would seem to be its most general mode of manifestation; whether in the motion of an atom, the motion of the ether, or the motion of a star, $E = V^2$. A thought that has (to use an expression of a now discredited diplomatist) staggered humanity frequently, is the utter insignificance of man and the world, in size, when compared to the mighty hosts of stars, millions upon millions in number, the most of them apparently of greater mass than our sun, and the vast spaces that separate them from each other and from us. Light, rushing through space at the pace of 186,000 miles per second, takes in many cases 200 years to reach us from some stars. Who has contemplated the problem and not been to some extent appalled by the utter littleness of man and all his works, his hopes and fears, his tiny ambitions as they rise and fall on the world-stage, which as but a mote flutters in the sunbeam? This is poetry, however, but hardly accurate prose. If one is liable to be overcome by the force of such pessimistic reveries, 'tis because he deserts for the moment the real and takes refuge in comparisons. We become impressed with the idea that bigness must necessarily be the mark of value, and littleness of girth the badge of plebeian parts. If we could find beings with heads the size of the moon (now you might say) and bodies in size like celestial Perseus or Orion, then these corporeal dimensions would surely seem to indicate importance sufficient to command respect. If a Parthian arrow were to pierce the heel of such a being, upward of an hour would elapse before he would be aware of it. The nerve sensations would take that time to reach the brain. Though man is comparatively so small, yet has he been able to so master the forces of nature as to compel them to do his bidding to a great and ever increasing extent. He has supplied himself with optical power for searching out his celestial neighbors and means for inquiring into their affairs, which if possessed in a natural way by a being built on the same plan as man is now, would require a corporeal frame in the dimensional proportions something like that just suggested, and the limits of this growing who can tell? The limit of optical power has been named again and again only to be pushed further on.

The aperture of the average human eye is one-fifth of an inch with a focus of about one inch. The aperture of the new Paris telescope will be five feet with equivalent focus (including eye piece) of 50,000 inches. This optical power, if regarded as an eye in a being built on the same plan as man, in like proportions, would require his head to be about six miles broad to contain it, and a body totaling sixty miles in height and weighing a million million tons, whose bulk if converted into anthracite coal at $10 per ton would represent a being worth in round numbers ten times that many dollars. So much for bigness. But if we compare man's bulk to that of the infusorial microbe, the molecule or the ultimate atom, his body is then ex-

cessively coarse and he becomes a monster so gross in proportions as to be utterly beyond the comprehension of the animalcular mind. We take the microscope, however, and this manipulation of optical power enables us to reduce our focal vision to the extent that we can, with artificial eyes, peer into the kingdom of the minute, associate with, and appreciate the manners and customs of the microbe, see as he sees, dissect him and approach the essence of material structure. Man can, therefore, now at will, by the application of scientific art and skill with optical aid, rise until his head literally towers among the stars or shrink upon himself almost to a mathematical point where he may associate with life in a waterdrop and play with the bricks with which the Great Artificer has formed the universe. So that it would appear when anything like a cosmopolitan view of astronomical and physical knowledge is entertained, man's place in the Cosmos is not so entirely insignificant as a casual glance or a one-sided comparative view might at first seem to indicate. A certain poet, appearing in public, overhearing an unfavorable comment as to his want of height and girth, is said to have turned and remarked:

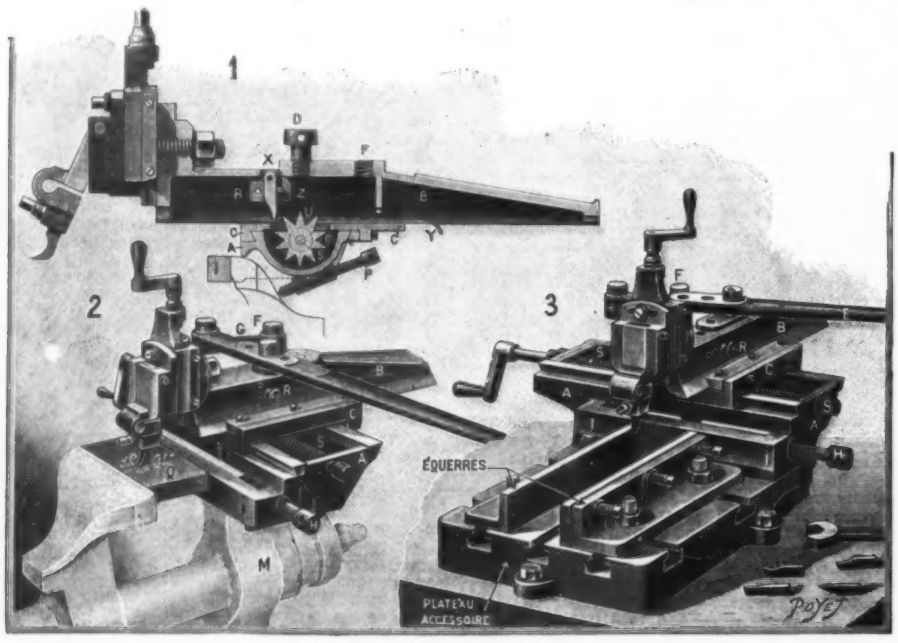
"Could I in stature reach the pole
And grasp creation in a span
I'd still be measured by the soul;
The mind's the measure of the man."

This view is advanced rather as a crumb of comfort to those worrying over the insignificance of man, than as an apology for the Artificer of the universe.

In closing, I might say that of course it is understood that while there can be no shadow of a doubt as to the existence of an ether of some sort, theories in regard to its ultimate structure are put forth provisionally, in order that an intelligent view of its subtle workings may be had and that the facts as they become known may be arranged in something like rational order.

AUTOMATIC PLANE.

MM. Jacquot and Taverdon, manufacturing mechanicians, have recently devised a new type of plane for



AUTOMATIC PLANE.

1. General view and internal section of the tool-carrier slide. 2. The plane mounted upon a vise. 3. The plane mounted upon a bed.

the working of metals, and which may be quickly fastened in any kind of a vise with the greatest facility. The apparatus is so light that it can be easily carried from one vise to another, or be placed in a tool-bag for doing out-of-door work, or be used on pieces of metal that are too large to be worked upon machine tools. It advantageously replaces the file and chipping chisel from the view-point of economy, rapidity, and perfect execution of the work; and cuts, grooves, faces, and shapes the hardest steel with the greatest precision.

The accompanying figure gives a detailed view of all the principal parts of the apparatus. At 1 is a general view and internal section of the tool-carrier slide; 2 shows a plane mounted upon a vise, and 3 a plane mounted upon a bed.

The plane consists essentially of a frame, *A*, which may be easily placed in the jaws, *M*, of a vise. This frame is formed of a semi-cylindrical box, the upper edges of which constitute the slides upon which a carriage, *C*, moves. In the center of the box is placed a horizontal screw, *S*, which controls the motions of the carriage. The frame, *A*, carries at the side a stirrup, *I*, in which engages the stationary jaw, *M*, of the vise. One side of this stirrup is traversed by a tightening screw, *H*, which bears against the jaw, *M*, upon which rests a feather formed integrally with the support, *A*. The stability of the whole is perfectly assured by means of a set screw, *P* (No. 1), so arranged as to clamp the rear part. After the plane has been mounted upon the stationary jaw of the vise, the latter is opened and the pieces to be worked under the chipping chisel carried by the slide are secured at *Q*. Upon the carriage, *C*, which is controlled by the screw, *S*, is placed a tool-carrier slide, *B*, that constitutes the plane proper. This is provided with a head of double inclination, in which the chisels may be placed, and is moved laterally through the to and fro motion of a hand lever, *E*, with which it is connected at the axis, *D*. The lever is jointed, by means of a rod, *G*, with a stud, *F*, set into a shoulder formed integrally with the carriage. The tool-carrier head is capable of assuming various positions according as it is a question of planing horizontally, or vertically, of grooving obliquely, or of truing an inclined surface externally or internally.

As a general thing, as is well known, the mechanical planing or facing of a metal surface is done by forming by means of special tools a series of small furrows very close to one another. With the plane under consideration, a forward motion is given the tool-carrier slide by means of the lever, in order to remove a certain quantity of material, and the carriage, *C*, is afterward made to advance by revolving the screw, *S*, that controls it. A very interesting arrangement permits of obtaining such displacement automatically. The screw, *S*, is provided with a longitudinal groove, in which engages the snug of a star-wheel, *O*, traversing an aperture, *U*, in the carriage, *C*. The star-wheel in revolving at a certain angle carries along the screw by means of the snug engaging with the groove. The motion of the star-wheel is brought about by utilizing that of the slide, which carries, suspended internally from a horizontal axis (No. 1) a tappet, *X*, that may be keyed in front or in the rear by means of a pin. When the slide moves, the tappet, which is carried along in the same direction, meets the star-wheel, and, according as the pin is placed on one side or the other, leaves the wheel stationary or causes it to revolve. In the second case, in fact, the tappet, upon meeting the star-wheel, inclines in the direction of *Z* and passes above without acting. The change of direction of the carriage is obtained by simply placing the pin, *R*, on the other side of the tappet, *X*. An automatic stoppage of the motion is obtained by raising the tappet above the pin.

Up to the present, we have spoken merely of the mounting of the plane upon a vise, but, since the bottom of the frame, *A*, is perfectly flat, the tool may likewise be mounted upon a bed (as shown in No. 3 of the figure) by means of two bolts. The clamps at the side are designed for holding in place the piece of metal to be worked. The automatic plane is therefore adapted for work of high precision. The slide has a travel of 7.25 inches, and the carriage a travel of 10. It is therefore possible to plane a surface of 69.75 square inches. —Translated from La Nature for the SCIENTIFIC AMERICAN SUPPLEMENT.

THE CURIOUS PLANT-BREEDING STATION IN SWEDEN.

AT Svalof, in Sweden, is maintained one of the most interesting agricultural experimental stations in the world, where are carried out elaborate investigations and experiments for the development of new, improved, and more prolific varieties of agricultural plants. So far this institution has only devoted its labors toward wheat and other cereals and peas, but the results attained have been of inestimable value, and as the station develops, attention will be directed to other plants of commercial and edible utility.

The institution owes its origin to private enterprise, having been inaugurated by a wealthy landowner and agriculturist, Mr. B. Welinder, of the province of Schonen. A few years ago this gentleman made an extensive journey through Great Britain and Germany, investigating the wheat and other cereal industries. Many of the foreign varieties of corn he examined were more prolific in production than those in vogue in Sweden, and for experimental purposes he devoted a section of his own estates to the raising of these foreign varieties of grain. One of these was that known as the British Square Head, and a quantity of this variety was distributed by Mr. Welinder among his neighbors. These agriculturists discovered that with the same labor which they devoted to the raising of the native corn, this British variety was more fruitful, since they harvested nearly 2,000 kilos per hectare of the latter to 1,200 kilos of the former.

The success of this experiment urged Mr. Welinder to further effort to improve the agricultural conditions of his estates, and, supported by other interested landowners, he founded the South Swedish Society for the Breeding of Seeds, for the scientific investigation and the improvement, introduction, and originating of varieties of grain and forage crops. A seed company was formed to act in concert with this association, the present capital of which is $100,000. The objects of this company, the shares of which are owned by the farmers and landowners, are to cultivate in large quantities and distribute advantageously and economically seeds of the cereals and fodder plants which have been originated or tested by the breeding station and proved to have special agricultural value. The valuable work carried out by this company soon attracted attention in other parts of Sweden, and so widespread was the interest evinced in the project, that the area of the society was rapidly extended over the whole country. As the association rose into significance, and the benefit accruing from its experiments was recognized, the attention of the government was directed thereto, and it was urged to support the scheme. This has been done, and the association now receives an annual government grant of about $5,000, and this sum, together with the 700 to 800 membership subscriptions, grants from agricultural societies, and receipts from sale of grain, etc., supplies an income approximately of $14,300. The organization already pays its way and promises to become in the near future a commercial success.

The Svalof Breeding Station comprises a modern laboratory inclosed by a small park. Surrounding the station are some 2,000 experimental plots, aggregating over 25 acres, scattered among larger fields of pedigreed grain under the direction of Dr. N. H. Nilsson. Not only are experiments carried out by this station with various grains, but sufficient quantities of the best seeds are cultivated for sale.

The soil for the experimental plots is not specially prepared or fertilized to raise the prolific abundance of the crops, which would not be a fair test, but is perfectly normal, being only prepared to the extent of an ordinary cornfield, and to insure further accuracy in these trials, each variety is tested on no less than three different plots.

The work of the station may be said to be carried out on two lines only. These are respectively the search for mother plants for producing new varieties; and as the test proceeds the gradual elimination of the less productive branches, so that only the most prolific grains are kept; the selection of the mother plants is based upon three principles: (1) the general qualities of the plant itself; (2) its ability to produce plants of high average quality; and (3) its ability to produce plants of nearly absolute uniformity in botanical characteristics.

The lines upon which the experiments are carried out are approximately the same for all crops. Upon the first plot a quantity of seeds which it has been decided to raise are planted. At the end of the year the best plants are selected—the standard of choice being those seeds whose uniformity of type and general excellence of yield have been demonstrated. These are then planted in similar plots the next year, and once more the best plants—provided the characteristics which resulted in their selection from the first bed are maintained—are taken to be planted in the third and final plot. By this elaborate series of tests the highest grades of corn, which last as a rule from eight to ten years, are obtained and are then raised upon a sufficiently large scale to enable samples to be sold for extensive cultivation. But in addition to raising these new varieties, a good deal of other beneficial work is carried out. Every year the station continues its work of improvement by selecting from varieties already on the market. From the trials of these a new representative plant is selected each year, the seed from which is sown, and the produce of which goes through the same processes as that of the new varieties.

By this unique system of cultivation, which effects the weeding out of all the unprofitable varieties of seeds, so that only the survival of the fittest remain, many valuable varieties of new seeds have been obtained and have proved highly successful when raised upon an extensive scale for the market. Among the more notably valuable varieties produced at this station may be mentioned the Grenadier wheat, which has yielded over 70 bushels per acre where the previously considered good kinds gave but 35 bushels; the Svalof Princess barley, which took twenty out of twenty-eight prizes offered by the Breweries Association at a recent show at Malmo, Sweden; and a variety of vetch (*Vicia sativa*), the most salient and important characteristic of which is its immunity from the mildew (*Peronospora*) which has for several years almost completely destroyed the fields of this fodder plant at Svalof. This vetch was found by Dr. Nilsson in a field which had been devastated by the disease, and he observed that it was comparatively free from the complaint. The station has also substantiated conclusively many scientific truths which will be of inestimable value in the carrying out of similar experiments with corn in other parts of the world. One of the most interesting of these is that the purely botanical characters of a plant have correlated with them valuable economic ones. For instance, the close-headed wheats have proved to have the strongest straw, and that the three-flowered spikelets of the oat bear the largest grains. Dr. Nilsson considers that the value of a pure botanical variety cannot be exaggerated. In the production of a barley for brewing purposes uniformity of germination is of prime importance, and at the Swedish Brewers' Exposition at Malmo in 1898, all the varieties of barleys which withstood the test and attained the prizes were botanically pure, or nearly so. Those varieties which were mixtures of several strains were invariably of inferior quality. None of the existing kinds of cereals now sold is botanically pure, but are rather mixtures of many different strains which Dr. Nilsson has separated and identified.

CRUDE AMMONIA AS A FERTILIZER.

AGRICULTURE owes its remarkable development during the last dozen years to the rational application of various fertilizers. The commerce in these is extraordinary, contributing to the general progress and to the increase of public wealth. The special industries concerned in their preparation, from superphosphates to seed cakes and various residues, are prosperous, and confer benefits of unquestionable importance. A new fertilizer, ammonia refuse, is now occupying at-

tention, as the results of experiments in the South, as well as in the North, have been satisfactory.

The crude ammonia is the exhausted purifying material used in the preparation of illuminating gas. As M. Dehérain has shown, coal contains about one hundredth of its weight of nitrogen, which is disengaged, when the coal is distilled, in the state of ammonia, and remains in the condensed waters, or in the matters which serve for the purification of the gas. If these waters and substances are heated with lime, they yield ammonia, which is retained in sulphuric acid. Thus we have ammonium sulphate, whose efficacy is well known, when it is applied to certain lands, provided it does not contain other substances injurious to vegetation, such as sulpho-cyanides. In the matters which serve for the purification of the gas, there will always remain an amount of nitrogen. This, such as it is, is buried in the soil.

M. Muntz has lately experimented with these fertilizers and has rendered a very instructive report, which M. Couture has analyzed in these terms for the Society of French Agriculturists:

"Ammonia refuse contains nitrogen in the state of ammoniacal salts, cyanides, sulpho-cyanates and insoluble organic compounds. Nine analyses have yielded nitrogen, from 2.68 per cent (minimum) to 13.95 (maximum), of which these are the proportions: nitrogen in the ammoniacal state, 1.07 to 6.58; sulpho-cyanide and cyanide, 0.72 to 2.23; insoluble nitrogen in the organic state, 1.01 to 5.15."

The experiments were made on: (1) light lands in the national domain of Joinville-le-Pont; (2) argillaceous lands, domain of Vergnes (Gironde); (3) silico-argillaceous lands, domain of Alvent (Dordogne). The tests were on wheat, oats, potatoes, beets, natural meadows, with comparison parcels treated with ammonium sulphate. The quantity of nitrogen was 50 kilogrammes per hectare.

1. Employment *en Couverture* (Mulching) on Wheat, Oats, Growing Grass.—The results were not satisfactory in consequence of the injurious effects of the cyanides and sulpho-cyanides. Even with the proportion reduced to 2 per cent of sulpho-cyanic acid, on some days the leaves were burned and vegetation was arrested. As a conclusion and absolute rule, never apply the refuse on growing plants.

2. Employment on the Bare Soil.—In certain cases the refuse was spread before plowing, buried by the plow, and incorporated in the soil. In other cases, it was spread on the surface just after plowing.

Wheat.—The application of the refuse took place after November 1; the sowing, a month later, December 1. The refuse was so proportioned that there would be 50 kilogrammes of nitrogen to the hectare for the parcel treated with ammonium sulphate. There were no bad effects on the germination and starting of the wheat, although the lots employed contained 2.55 per cent and 4.96 per cent of sulpho-cyanic acid. The result was about the same as that of the parcel treated with ammonium sulphate. The lands had received a regular quantity of phosphated and potassic farm manure.

Oats.—Test on neglected lands covered with weeds, couch grass, etc. The refuse was applied in December, either simply *en couverture* or buried. In the following spring the oats were sowed. The vegetation was quite rapid and vigorous, as compared with the oats in the parcel treated with ammonium sulphate. In the course of the vegetation, as well as at the harvest, it was found that in the beds which had received the ammonia refuse, the weeds had completely disappeared, while they were abundant in the parcel treated with ammonium sulphate and in the parcel treated with farm manure. It follows that ammonia refuse, by its poisonous properties, had destroyed the weeds. In the particular case, the favorable results were superior to those obtained by the application of ammonium sulphate.

For weeded plants and beets, the refuse was spread on February 7; the sowing took place two or three months later; the harvest in October exhibited results, some equal, and some superior, to the parcels treated with ammonium sulphate.

The conclusions of M. Muntz in presence of these important results are thus summed up:

1. Ammonia refuse may be employed in agriculture.
2. It should not be applied *en couverture*, or otherwise, on plants in a state of vegetation.
3. It should be applied on the soil a month or six weeks before sowing, so that the poisonous substances, such as the sulpho-cyanides, very unstable combinations, may be decomposed and exert no harmful influence.

The comparative results obtained on different soils have been the following: The soils in which the refuse produces the greatest effect, are calcareous, silicious or silico-argillaceous, provided that the latter contain lime. It should not be used on stiff soils.

Since the remarkable tests of the director of the laboratory of the National Agricultural Institute others have been made, notably by the agricultural professor of the Department of Aisne, which have been attended with very good results. Thus, in the region of the Aisne, the employment of ammonia refuse, of which the nitrogen cost at the rate of .60 franc per kilogramme (a price lower than those of sodium nitrate and of ammonium sulphate), was general in the culture of beets. From the data collected, it appears that the raisers of sugar-beets applied in the after season, and buried by harrowing, 100 kilogrammes of ammonia refuse per hectare; this quantity is sufficient.

As there are gas establishments in all cities of any size, this fertilizing material may be utilized generally. It also possesses insecticide properties.

M. Couture has stated to the Society of French Agriculturists that gases of establishments of small cities are those where the refuse is the richest in nitrogen, because the condensing and washing processes employed for retaining the ammoniacal salts and ammonia are less improved than in the large cities. Then, proximity to cultivators affords a certain market. But there is occasion before employing a certain lot to have an analysis made; for the composition varies according to the treatment of the gas factories and the nature of the coal employed. The naphthaline and tar, which are drawn in small quantities into the purifiers and are found in the proportion of about 1 per cent in the refuse, exert no action on vegetation.

Count Roederer has endeavored to utilize ammonia refuse for destroying couch grass, but his experiments have not yet been conclusive.

This fertilizer has only been employed for two or three years. It is therefore not possible to ascertain yet all its fertilizing qualities. It is a new element of progress in French agriculture, and all benefit possible will be drawn from it.—Translated from Le Bulletin des Halles.

A NEW METHOD OF STUDYING STORMS.*

By EMILE GUARINI.

AT the last meeting of the Milan section of the Italian Electrotechnical Association, steps were taken to institute a service to collect information and statistics pertaining to storms in Italy. For the purpose

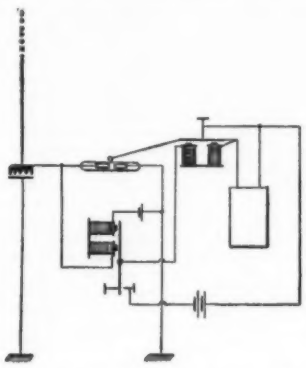


DIAGRAM OF THE LERA APPARATUS.

of assisting observers in gathering information, the association has distributed copies of bulletins in which instructions are contained. These bulletins have been sent to electrical plants, schools and colleges, to various industrial establishments throughout the country, and to persons capable of collecting data on the cause, duration, and intensity of storms. The material thus gathered is to be studied and discussed by the Electrotechnical Association, the intention being to prepare a report in which conclusions will be given of value to industries at large and to the electrotechnical industry in particular. The leading spirit in this movement is the Italian physicist Boggio Lera, professor at the Electrotechnical Institute of Catania. He began work in 1899. Since that time he has succeeded in collecting much valuable material, having been aided chiefly by the apparatus installed in the various Italian and Sicilian observatories.

The study of storms is of immense importance to electrical engineers, for the effect of atmospheric discharges of electricity on power plants is only too little understood.

By means of apparatus which he has invented and set up in the Catania observatory to record atmospheric electrical effects and to follow the course of the storms, Boggio Lera has succeeded in registering the septentrional, fulgurant discharges which have been seen in the vicinity of Turin, Milan, and other Italian towns. The methods adopted by Lera are simple enough.

He compares the records given by his apparatus at Catania and throughout Sicily with those which are furnished by the meteorological observatories of Italy and of other countries. From these comparisons he conjectures with approximate accuracy the places whence come the discharges registered by his apparatus.

Let us suppose that the Lera apparatus at a given day and at a given hour has registered signals which could not have come from Catania or from Sicily, the heavens being clear and other observations proving that atmospheric electricity could not influence the apparatus. The Italian observatories did not record any storms at the time the signal was received. Lera therefore concludes that the lightning discharges registered by his apparatus must have come from a point without Italy—from Greece for example, or from Algeria, in other words from a distance of 250 to 300 miles.

Let it be supposed again that the apparatus at a certain day and at a certain hour has registered electrical discharges which, for reasons already given, could not have come from the vicinity of Catania, nor from any part of Italy. The Turin observatory alone has recorded lightning discharges on that particular day and at that particular hour. Lera, therefore, concludes that his apparatus at Catania has registered the fulgurant phenomena produced at Turin, a distance of 621 miles.

The apparatus by which Lera is able to accomplish these remarkable feats is exceedingly simple—perhaps even simpler than that which was employed for the same purpose by Popoff in 1894. As shown herewith, an antenna is connected with the earth, with a coherer, with a lightning-arrester of the comb type, and with a condenser provided with mica sheets. The coherer is included in the circuit of a battery and a relay which energizes a battery and rings a bell. The armature of the bell, when it is attracted, strikes the gong and attracts the attention of the observer. When the armature is released, by reason of the interruption of the current, it acts as a tapper to decohere the parts or the coherer. In another form of apparatus the signal is supplanted by a registering chronometer connected in parallel with the bell-tapper.

The method employed by Lera for following the course of the storm is no less ingenious. It is based on the fact that the action exercised by the atmospheric discharge on a coherer depends on the value $\frac{I}{D^2}$, D being the distance from the apparatus to the source of the discharges, I representing the intensity of the discharges. Since I is not equal for all discharges, since the discharges are not always produced at the same distance from the registering apparatus or signal, and since the zone swept by the storm may have a greater or less extent, it becomes evident that the discharges registered by the apparatus will be augmented or diminished in frequency as the quantity I is augmented or diminished and as the quantity D is diminished or augmented, in other words will vary with the augmentation or the diminution of the probability of the storm's arrival.

Long practice has confirmed many of the conclusions which Lera has reached. Four principles have been deduced:

1. The apparatus provided with an antenna of 20 feet being located at the Catania observatory situated at an altitude of 563.4 feet, the horizon being absolutely free, save in the direction of Ætna, is capable of signaling storms in a zone having a radius of at least 400 kilometers.

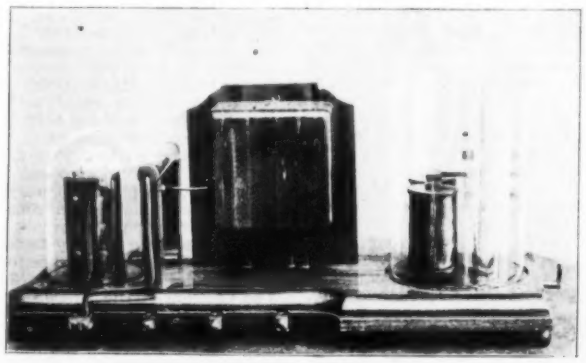
2. The registering chronometer signals the distant storm by small dashes, local storms by continuous dashes, and neighboring storms by almost continuous dashes.

3. The frequency of the discharges registered is in direct relation to the probability of the arrival of a storm; the augmentation of this frequency, with the rapidity of the arrival, so that a rapid increase of the frequency is almost a certain indication of the arrival of a storm.

4. The progressive and slow diminution of the frequency after a period of slow acceleration is an almost certain indication that the storm will not arrive, and that there is likely to be rain, or, at least, a change of the weather.

I cannot conclude this article better than by mentioning here the work of Lieut. Tissot, of the French navy, a wireless telegrapher, who has measured with the aid of a thermal galvanometer the energy of Hertzian waves produced by a very powerful transmitter at a distance of 4 kilometers (2½ miles). By providing this apparatus with registering devices, it would be possible to employ it in following the course of storms and in measuring the energy of waves sent out by different discharges. It should be possible to determine the average intensity of atmospheric perturbations due to electricity at a definite point.

* Specially prepared for the SCIENTIFIC AMERICAN SUPPLEMENT.



THE LERA APPARATUS FOR REGISTERING ATMOSPHERIC ELECTRICAL DISCHARGES.

THE ORIGIN OF THE THOROUGHBRED HORSE.*

THE author said that he had shown (Academy, January, 1891, p. 91) that not only, as had been long observed, did the Homeric Greeks drive the horse before they rode him, but that the same was true of all ancient peoples—Egyptians, Canaanites, Assyrians, Aryans of Rig-Veda, Umbrians, Celts—and that the explanation of this was given by Herodotus (v. 9), who, in speaking of the Sigynnæ, the only tribe north of the Danube whose name he knew, said that they had small horses, with large flat noses and very long hair, which, though not able to carry a man, were excellent under chariots: "wherefore they used charlots." Dio Cassius likewise says that the Britons used

* Abstract of paper read before the Cambridge Philosophical Society on November 24, by Prof. Ridgeway.

chariots in war, because their horses were "small though active." The description of the horses of the Sigynnæ tallies exactly with the abundant remains of the primitive horse of Europe, eaten in great quantities and delineated on antlers by the men of the Stone Age. He was a small animal about ten hands high, with a big head. Even after domestication he remained very small, as witness bits of bronze and horn found in Swiss lake dwellings, the shoes found at Silchester, and in camps on the Roman Wall, etc. Authorities are agreed that from this primitive horse has been developed the cart horses of the Continent and these islands, while our blood horses have come from an eastern stock of slight build and smart appearance. Our problem is to ascertain the original habitat of this superior horse. He has not come from upper Asia, as the Mongolian pony is taken as the type of the coarse, thickset horse from which sprang the cart horse. The Mongolian pony probably represents the Scythian horses, which continued to be of a small size down to Strabo's time, and they were derived either from the tarpan or Prezevalsky's horse. The Mongolian pony, though surefooted and enduring, is slow of pace. Neither China, Siam, nor Burma has any indigenous horse answering to the blood horse. India could never breed horses, says Marco Polo, in whose time India was supplied either with Mongolian ponies from Yunnan or with Arabs from south Persia, Aden, and other Arabian ports. These Arabs fetched enormous prices, equivalent to £200. It has hitherto been universally held that Arabia is the original home of the blood horse. This is a baseless assumption. In the old Testament, the Arabs are never mentioned as riding anything but camels and asses. Though the author of Job knew of the war horse, yet Job did not own a single horse, his equine possessions consisting of 500 she asses. Herodotus (vii. 87) enumerates the nations (including the Libyans) that supplied cavalry to Xerxes' host, but the Arabs only furnish a camel corps. Agatharchides (cited by Strabo) describes the Arabs as camel keepers.

Finally, Strabo (*flor.* A. D. 1) expressly states that neither the peoples of Arabia Felix nor those of Arabia Petræa bred horses. Naturally, then, Scaurus after defeating the Arab king Aretas put on his coins Aretas leading his camel. It is clear, then, that down to the Christian era the Arabs bred no horses. It is therefore clear that though the Persian kings in the fifth century B. C. bred the largest and best horses in Asia, these were not of an Arab strain. These horses were kept largely in Armenia, and are described by Strabo as similar to the Parthian horses, and as differing from the horses bred in Greece and the other kinds of horses known in the Roman empire. There can be little doubt that they were the same horses as Marco Polo found in great numbers in Armenia (1276 A. D.) known as Turquans, the Turcoman ponies well known in Persia to-day. The Persian horses cannot, then, have been the ancestors of the thoroughbred, though it is quite possible that their superiority was due to their having a cross of thoroughbred blood, for already by 900 B. C. Solomon imported horses from Egypt (I. Kings, x.), and "so for all the kings of Syria and for all the kings of the Hittites" Egypt could not breed horses, neither could she have got them from the Arabs, who bred none even 1,000 years later. But she could and did get them from the Libyans, who from the dawn of history are masters of the most famous horses. Cyrene sent the best horses to the games of Greece (Pindar, Pyth. iv., etc.). It is noteworthy that it was in the same century as the founding of Cyrene that the four-horse chariot and the racehorse were added to the Olympic events. The Phœnician' settlers at Carthage found the Libyans using these beautiful horses, and when they struck coins placed a horse or a horse-head on them as the badge of Libya, and used a similar type on their coins struck in Sicily, whither, doubtless, they carried the Libyan breed. This accounts for the extraordinary fame of the horses of Etna and Syracuse and the famous steeds of Tarentum. It is now clear that the Arabs never owned a good horse until they had become masters of North Africa and the Barbary horses, from whom are sprung our own racing stock through Lord Godolphin's Barb. North Africa, therefore, and not Arabia or any other part of Asia is the original home of the thoroughbred.

Now, though the pedigree of the cart-horse type can be traced to the coarse, thick-set little horses of Europe and Asia, the wild ancestor of the Barb is yet to seek, for Africa has no wild horse, such as tarpan or Prezevalsky's, though she has an ass and four zebras, including the quagga, now extinct. Can the Barb be sprung wholly or 'n part from a zebra? Arab foals at birth constantly have zebra markings, sometimes retained when full grown, as by Prof. Ewart's Arab filly Fatima. Strabo, too, notices that the horses of the Libyan Garamantes have longer hoofs than any other horses. Prof. Ewart's hybrids from Burchell's zebra and various mares show the markings, not of a Burchell's zebra, but of a Somaliland zebra, from which it has been inferred that the remote ancestor of both *Equus caballus* and Burchell's zebra was striped like the Somaliland and mountain zebra. But is it necessary to go back so far? May not the Somaliland zebra stripes in the hybrid be due to the circumstance that the dam in each case had a certain amount of Barb blood in her, which was derived from either the Somaliland zebra or a closely allied species? He (Prof. Ridgeway) had crossed a Muscovy drake with a common white duck, derived from the common wild duck, with the result that all the offspring are colored, and their coloring resembles that of the mallard. No one would say that the hybrids show a reversion to a remote common ancestor of both mallard and Muscovy, for it is obvious that the coloring is simply that of the white duck's immediate ancestors. Authorities like Captain Hayes have pointed out the great similarity in form between Burchell's and the Somaliland zebra to a well-bred horse, i. e., a horse that has Barb blood in him. He therefore suggested that the Barbary horse, from which he had shown all the fine horses of the world have sprung, was derived either from the zebra of northeast Africa or, as is more likely, from some very closely allied species, now extinct, which, like Prezevalsky's horse, may have had castors on its hind legs like *Equus caballus*.

ENGINEERING NOTES.

The crucible process of making fine steel, says Sparks from the Anvil, will probably never be superseded by other methods. Selected irons with their "medicines" are melted in crucibles which are luted and sealed, where chemical reactions take place unseen and unaffected by outside influences. For securing high quality, accuracy of what the steel maker calls "temper," there is no substitute process in sight. When steel has been overheated the property called temper is destroyed. This may in a measure be recovered by careful manipulation.

The German papers have recently been circulating the report, and it has even gained currency in the English press, that the locomotives which have been purchased in America by the Bavarian state railways within the last three years had proven unsatisfactory, and that their durability had been called into question. In these reports it is also asserted that experts had declared that the American locomotives could only last at best from eight to ten years, while the locomotives manufactured in Bavaria had stood service for thirty years, and that for these reasons, as well as because of frequent necessary repairs, the further use of American locomotives had been abandoned. From official sources the information is obtained that these reports are unauthorized and wholly groundless. The facts are that the locomotives which had been bought in order to study the American system of locomotive building have proven, because of their simplicity, their originality of construction, and their remarkable locomotion for fast and freight trains, most acceptable, especially as to durability and efficiency, and that up to this time nothing has been discovered to warrant a statement that, with the same care bestowed upon them as upon the Bavarian locomotives, the American locomotives would prove less durable than those built here. Indeed, many of the parts of construction have been found so simple and practical that they will be adopted in the construction of Bavarian locomotives.

During the present summer attempts are to be made by the various railroads of Great Britain to establish new records in connection with the running of express trains for long distances without a stop. At the present time the record in this connection is held by the Great Western Railroad, which runs a train daily from Paddington to Exeter, a distance of 194 miles, in 3¼ hours without a single stop. The Great Northern Railroad will also run the "Flying Scotchman" from London to Doncaster, 156 miles, without a stop; thence similarly from the latter station to Newcastle-on-Tyne, 112 miles; and from there to Edinburgh, 124½ miles; the whole distance from London to Edinburgh, a total of 392 miles, being covered with only two intermediate stoppages. But these efforts are to be eclipsed by the London and North-Western Railroad, which is to run trains from London to Carlisle, 299 miles, without a single stop in six hours. For this long run special engines have been designed by Mr. Webb, the superintendent engineer of the system, and the experimental trips have been carried out with conspicuous success. Water troughs have been laid down upon the track at suitable places, so that water may be picked up while the train is traveling at full speed. The average speed will be 50 miles per hour. The locomotives will carry six tons of coal to last the journey; and as stoking under such circumstances is continuous, two stokers will be carried on the engine, so that the men may obtain a few minutes' relief alternately. The strain of continually stoking throughout six hours, would be too severe for one man to accomplish.

The British Naval Department has announced its intention to abandon the practice of subsidizing the leading and foremost vessels of the mercantile marine of Great Britain for naval purposes, except in those cases where the vessels have special speed and great coal capacity. When the White Star and other British mercantile fleets were merged into the Atlantic combine the question was raised as to whether the Admiralty would continue paying the subsidies for the vessels which had been incorporated in the trust, in view of the fact that they had been practically Americanized. The result of this motion was to cause an inquiry to be made into the whole question of subsidizing mercantile vessels. A special committee was appointed. The committee, as the result of their investigations, recommended the abolition of the subsidies except in those instances where the vessels had a speed of 20 knots per hour. Few of the ships engaged in the transatlantic or Oriental trade of Great Britain can attain such a speed, and consequently, owing to the fact that there are several warships capable of attaining speeds varying from 19 to 23 knots per hour, it is perfectly obvious that the utility of any mercantile vessel of a lower speed is altogether inadequate and unsuitable for naval purposes. The committee in their decision have been somewhat influenced by the practice in vogue in Germany, where mercantile ships of 22 knots or over only become auxiliary cruisers to the navy, and that there are four German vessels which have a speed varying from 22 to 24 knots per hour. The decision of the British Admiralty affects eighteen vessels, not only engaged in the Atlantic traffic, but in the Oriental and Australian trade as well. By this abolition of subsidies the naval department will effect a saving of $389,065 per annum, for which sum, however, it must be pointed out that in addition to the eighteen first-class ships of the mercantile fleets subsidized, thirty-one other ships of smaller dimensions and lower speeds are available to the navy in case of war. At the time when the project of subsidizing mercantile ships as auxiliary armed cruisers was formulated, they were the fleetest vessels afloat, but since then the speed of warships has been steadily increasing. Consequently, if mercantile vessels are to prove of any utility to a fleet it is imperative, in view of the work they are required to fulfill, that they should be faster than the warships. The inquiry committee recommended the subsidizing of vessels of a minimum speed of 20 knots, but the British Admiralty have decided to increase the minimum limit to 23 knots per hour, so that such subsidized ships may be of distinct practical advantage to the navy.

ELECTRICAL NOTES.

The telegraph system in Uganda now extends to Batiaba, on the shore of the Albert Nyanza. The trunk line from Mombasa, with its branches, is over 1,034 miles in length, and the charge over the whole distance is 2d. a word, with a minimum of 1s. 4d. for a message of eight words. There is also a system of telephones along the whole distance, which may be used at 1s. 4d. per conversation. The poles on which the wires are fixed are living trees.

The Russian Naval Dapartment propose carrying out a series of experiments to ascertain whether the presence of electric lighting cables exercises any injurious effect upon the constructional steel work of a warship. The Admiralty is of opinion that high-tension cables which are used on a war vessel shorten the life of the boilers and the steel work of the ship by the electrolytic action that is set up. To obtain conclusive data upon this point, one of the seven torpedo-boat destroyers now being constructed for service in the China seas is to be fitted with oil only as an illuminant, while the others will be fitted with the electric light. By comparing the results observed on the oil-lighted and the electrically-illumined vessels, more substantial evidence upon the subject will be available.

One of the difficulties to be overcome in constructing a sensitive platinum thermometer is to restrict the size of the coil of wire forming the bulb. In order to have a sufficient length of wire, it is often necessary to make the bulb inconveniently large, and thereby sacrifice quickness of register. A form of thermometer described by Messrs. H. T. Barnes and D. McIntosh overcomes this difficulty to a considerable extent. Briefly, the thermometer consists of two concentric glass tubes fused together at the end, with the wire wound on the inner tube in a thread etched into the glass. The main point about the thermometer is that a core passes through the center of the bulb, through which the liquid or gas the temperature of which is desired can be made to flow. It is claimed to be quite as easy to construct, if not more so, than the mica-frame type, and it unquestionably has advantages over the latter for the particular use for which it was designed—the apparatus in question was specially adapted for the continuous-flow calorimeter—although it would be unsuited for certain types of temperature measurement.

Prof. G M. Minchin, of the British Royal Society, has devised a new coherer for receiving the Hertzian waves. It comprises a carbon pencil about five-eighths of an inch in thickness, which fits loosely in a horizontal position in two loops made of aluminium wires, the latter support being formed in the shape of a stirrup. This device is inclosed in a glass tube into which are sealed two platinum wire electrodes. One electrode is connected to the center of the stirrup, while the other is just immersed in the mercury, which is placed in the lower part of the tube. There is a third platinum wire attached to the carbon pencil and reaching the mercury, thus completing the connection. The space above the mercury in the tube is filled with mercury vapor, obtained by boiling the mercury within the tube for some time before the tube is sealed. The receiver consists of a large metal plate mounted on a pole; and the object which the plate has to fulfill is to receive the electric impulses transmitted. The plate is earthed through a coil of large inductance but small resistance. The carbon pencil coherer, a single dry cell, and a telephone form a short circuit, ramifying from the earth wire of the receiver plate above the coil. Prof. Minchin has submitted this ingenious receiver to several experiments, and it has shown great sensitiveness, the telephone indicating infallibly every dot and dash transmitted from the distant oscillator.

According to the London Electrician, a scheme has been proposed for obtaining electricity for use either at the central station or among a special class of consumers in the area of Dundee in connection with the docks of that town. The scheme in question is fully described in a late issue of the Dundee Advertiser. The name, however, of the author of the project is not given, but our contemporary states that its details have been carefully examined by a firm of electrical engineers and reported on favorably. It seems from the commencement of the article that the docks at Dundee are not extremely successful. If the scheme were adopted they would cease to exist as docks and would simply become reservoirs, into or out of which the tidal water would flow, driving turbines on its way. The area of these docks and the heights below low water and high water will be presumably as given in the article, and the estimated cost of making use of the power is only £8,500. We should be inclined to doubt if the civil engineering work involved could be carried out for this, but our criticism of the scheme will not be on this score. The estimate states that for 16 hours per day 120 horse power could be obtained from the water flowing into or out of King William Dock and 100 horse power out of Earl Grey Dock. In estimating the revenue from the undertaking, the output is multiplied by 16 as the number of hours per day and by 365 as the number of working days per year. This gives the output available in Board of Trade units, which are reckoned to be sold at 4d. per unit. It must be remembered that the period each day during which power is to be obtained varies with the state of the tide, and that it is most unlikely that any consumer of power could be found who would only require it during the 16 hours in question. If he did, it would have to be sold to him at less than 1d per unit in order to compete with steam plant installed for such a regular load each day. This reduction would at once bring the revenue down from £16,000 per annum to £4,000 per annum. We are afraid also that the intermittent use by other consumers would reduce even this £4,000 to below the author's estimate of cost, which is £1,670 per annum. Over and above this the docks would be quite useless for their present purpose, and we presume that the capital spent on them is hardly looked upon as wasted by the Dundee Harbor Board. The only chance for a scheme such as that proposed is where there is a large estuary available with a small tortuous inlet. In fact, the local conditions have to be so special that practically no successful tidal power station exists at the present day.

TRADE SUGGESTIONS FROM UNITED STATES CONSULS.

Industrial Conditions in Peru.—Electrical Enterprises.—Of late years there has been a notable extension of electric force and electric lighting in Peru. Lima is now lighted throughout by electricity, and in many establishments the machinery is driven by electrical power. A number of the cities in the interior also enjoy the benefits of electric lighting.

Two syndicates have recently been formed in Lima for the construction of overhead trolley tramways. One is La Compañia Anónima Tranvía Eléctrico de Lima y Chorrillos. This company proposes to build an electric tramway from Lima to Chorrillos, passing through the small boroughs of Miraflores and Barranco, lying between Lima and Chorrillos. The distance is about 14 kilometers (8.6 miles). The line will be double tracked and the cars will run at intervals of about ten minutes. The capital is £80,000 ($389,320), divided into shares of £1 ($4.86) each.

The other company is called Ferrocarril Eléctrico de Lima y Callao. This line is also to be double tracked and will connect Lima and Callao, a distance of about 13.7 kilometers (8.5 miles). This company also intends to construct tramways in the city of Callao. Its capital is £100,000 ($486,650), and it intends to compete with the existing railways for the carrying of freight as well as passengers between Callao and Lima. The passenger trains are intended to be run, like those of the other company, every ten minutes.

The government gives to these two syndicates a privilege for sixty-six years. The two companies are to be free of taxes, and are to import free of duty for the term of two years all material for their own use. At the end of sixty-six years, the tramways, rolling stock, and all material become the property of the government, free of cost.

Both the electric tramway companies have made arrangements with American manufacturers for the supply of the plant and material to equip the lines, and it should soon begin to arrive, as the lines must be finished and in working order within two years from the date of contract with the government.

American Railway Enterprise.—The American syndicate now interested in the Cerro de Pasco, Morococha, Yauli, and other mining districts, which is constructing the railway from Oroya to Cerro de Pasco, has discovered that, in view of the immense increase in the quantity of ores that will be exported when the railway is concluded and the new machinery set up, the present railway between Callao and Oroya will not be able to handle the traffic. The managers have therefore directed their attention to the building of a line which, starting from a given point on the railroad under construction from Oroya to Cerro de Pasco, would run northward through some of the richest mineral and agricultural districts of Peru to the port of Paita. This line would be of the greatest importance to the country and would probably yield good results to those investing capital in it.

It would allow the export of agricultural and mineral products from districts now virtually unproductive on account of the high cost of transport; it would increase a hundredfold the production of those localities which, owing to the high rates of freight, can now scarcely hold their own; and, lastly, it would bring about an enlarged consumption of foreign goods, because the greater value of the exportations would bring about a greater demand for imported articles. Besides, Paita being a first-class port, untrammeled by the heavy dock charges and other expenses ruling in Callao, foreign goods would pass by this route up to the center of Peru at a much lower cost than if landed at Callao. The latter port, to maintain its importance, would probably find it necessary to erect bonded warehouses in which to store goods coming via the Panama canal from the United States and Europe. These goods could then be reshipped to Ecuador and even to northern ports of Chile.

The outlook for trade and for the employment of foreign capital is certainly encouraging. The long period of peace which the country has enjoyed has undoubtedly started it on the road to progress and has brought about a state of prosperity unknown in this republic for years.

Gold Standard.—Congress passed a law on December 14, 1901, adopting a coin called the Peruvian gold pound (equivalent in size, weight and fineness to the British pound sterling), demonetizing silver, and making gold the legal tender for all sums over 100 silver soles.* This law was put into effect on March 1, 1903, and now the gold standard is firmly established in this country. Ten silver soles are accepted and paid by the banks and everyone as the equivalent of the Peruvian or British sterling pound. The law also prohibits the importation of silver soles or silver coin, and no person coming into the country or passing from one port to the other can take on shore more than ten silver soles at any one time. If he does, the silver coin is taken possession of by the government, melted into bars, and returned in that form to the owner of the confiscated coin.

The government during the past two years has melted down over 1,000,000 soles, converting the same into ingots and selling the silver in Europe for British sovereigns. By reducing the amount of silver coin in circulation, the government expects to keep the gold in proportion to silver as £1 to 10 soles, or in British currency at the rate of 24d. (48 cents) to the silver sole.

The amount of silver in circulation in the country does not exceed the sums required for daily use and minor transactions; and in view of the undeveloped state of the natural wealth of Peru on account of the lack of foreign capital and foreign immigration, one may look forward to greater commercial activity and general improvement in the country.—Joseph C. Cree, Vice-Consul at Callao.

International Competition in South American Markets.—Consular Clerk G. H. Murphy sends from Frankfort copy of a letter to the Frankfort Zeitung from its correspondent at Buenos Ayres, relative to foreign competition in the markets of South America, of which the following is a partial translation:

"The statistics of the foreign trade of the Argentine Republic, which have just been published, reveal the exact extent of the influence exerted upon commerce by the bad crops of 1901-2 and by the increase of duty rates, in lessening both consumption and importation. The value of imports decreased from $113,900,000 gold in 1901 to $103,000,000 in 1902, Germany's share of this trade declining from $16,700,000 to $13,200,000 gold. Importations from Belgium, which naturally included many transit shipments from Germany, decreased during the same period from $8,700,000 to $5,500,000 gold. Thus the entire falling off in importations from Germany amounted to more than $4,000,000. The United States—whose importations into the Argentine Republic about equal in value those of Germany—and Italy suffered each a loss of about $2,500,000. Great Britain alone had a small increase—from $36,500,000 to $37,000,000—but this was due to the fact that coal and railway materials continued in demand, in spite of the generally unfavorable condition of the market.

"It seems probable, however, that in 1903 the amount of the falling off in 1902 ($11,000,000) will be at least recovered; for, while the wheat and linseed crops will probably not reach the fabulous figures recently predicted by the Argentine Minister of Agriculture, the exports of these two articles will very likely amount to $50,000,000 and $20,000,000 gold, respectively, an increase for these two cereals alone of about $35,000,000.

"It may be well to explain here the cause of the decreased importation from Germany. It is not due to United States competition in South America, as the United States has had very little success there, except in the Argentine Republic.

"The following tables compare exports from Germany and the United States* to the principal South American countries, the values being stated in United States currency:

EXPORTS FROM UNITED STATES.

Year.	South America.	Brazil.	Argentine Republic.	Venezuela.	Colombia.	Chile.
1892.	$33,100,000	$14,300,000	$2,900,000	$4,000,000	$3,100,000	$3,500,000
1894...	33,20 ,000	13,900,' 00	4,900,000	4,100,000	2,800,000	2,300,000
1896...	36,300,000	14,300,000	6,000,000	3,800,000	3,400,000	3,400,000
1898...	33,800,000	13,300,000	6,400,000	2,700,000	3,300,000	2,400,900
1900...	38,900,000	11,600,000	11,800,000	2,400,000	2,700,000	3,300,000
1901...	44,700,700	12,000,000	11,500,000	3,300,000	3,100,000	5,300,000
1902 ..	38,100,000	10,400,000	9,800,000	2,800,000	3,000,000	3,700,000

EXPORTS FROM GERMANY.

Year.	Brazil.	Argentine Republic.	Chile.	Venezuela.	Peru.
1892.	$12,350,000	$8,370,000	$10,750,000	$1,280,000	$1,400,000
1894..	13,500,000	7,180,000	5,450,000	1,470,000	1,000,000
1896.....	14,350,000	10,520,000	8,230,000	1,520,000	1,730,000
1898..... ...	10,750,000	10,630 000	4,830,000	1,020,000	1,620,000
19 0.....	10,870,000	15,230,000	9,490,000	1,190,000	2,350,000
1901.....	8,450,000	12,900,000	8,090,0.0	1,660,000	2,640,000

"The entire exportation of the United States to South America has increased $5,000,000 during the eleven years 1892-1902, but what does this mean when it is remembered that during the same period the aggregate exports of the United States to other parts of the world increased $400,000,000? Moreover, were it not for the increased purchasing power of the Argentine Republic—which has enabled the United States during the period mentioned to increase its exports to this one country to the extent of $7,000,000—there would have been not only a relative but an actual decrease in the total value of exports from the United States to South America.

"German exports to the Argentine Republic, it will be noted, have increased at almost the same rate as those of the United States.

"In Brazil, both the United States and Germany have lost ground, not only in exports, but also (owing to low coffee prices) in imports. The importations of the United States decreased from $118,600,000 in 1892 to $79,200,000 in 1902, Germany's decrease being from $32,300,000 in 1892 to $27,100,000 in 1901. On the other hand, Germany's importations from the Argentine Republic increased in these years from $20,700,000 to $47,800,000, while the importations of the United States only increased from $5,300,000 to $11,100,000 in the eleven years 1892-1902. During the same period, Chile's exportations increased as follows: To Germany, from $17,850,000 to $24,030,000; to the United States, from $3,500,000 to $7,700,000.

"Germany has accordingly, during the past ten years, succeeded in maintaining in South America the second rank after Great Britain. Her strong position is based upon the vast productive capacity of German factories, and also upon the readiness of German exporters to meet the wishes of their foreign customers.

"In giving these figures, I do not wish to encourage too great a feeling of security, for it is natural that the North Americans will continue in the future to work with energy for the strengthening of their position in a market where they have already had some success."

Coal in Germany.—Although the agreements of the Rhenish Westphalian Coal Syndicate are officially binding until 1905, negotiations are already under way for its reorganization on a new basis for a term of ten years from July next. The syndicate is to represent not only the collieries already incorporated, but also the non-incorporated enterprises. With the exception of the Haniel and Thyssen collieries, the negotiations have proved most successful, and it was confidently anticipated that these, too, would soon be prevailed upon to join. Strict regulations have been enforced in reference to the sinking of new shafts, and it is chiefly to these regulations that the Thyssen collieries take exception, this enterprise having a considerable undeveloped area. It is still possible that matters may be arranged satisfactorily for all the parties concerned.

As appears from an interesting report in the Berg und Huettenmaennische Zeitung, the northern boundary of these Rhenish-Westphalian coal fields is being pushed forward from year to year. At present they are bounded by an imaginary line starting in the west on the left bank of the Rhine near Buenderich and extending eastward through Schmerbeck and Hebern as far as Beckum over a distance of 105 kilometers (65.24 miles). One company is already reported to have the intention of pushing its derricks eastward in the direction of Oelde. An indication of the great activity which has prevailed until now is found in the fact that during the past three years more than thirty bore holes have been sunk outside the worked area on both sides of the Lippe and have all struck the carboniferous layers, although mostly at considerable depth. The deepest bore holes in the Lippe region are near Schermbeck (914 meters = 2,999 feet), Spellen (925 meters = 3,035 feet), Huemxe (938 meters = 3,077 feet), and Beckum (1,012 meters = 3,320 feet). Besides these a great number have been brought down to a depth of from 800 to 900 meters (2,624 to 2,786 feet). Several concessions have already been finally secured in this part and five of these have started with the sinking of shafts.

Anthracite.—According to the Echo de Mines et de la Metallurgie, all the bore holes sunk in the neighborhood of Metz have proved the presence of anthracite coal. Three borings executed by the principal local parties have given the following result: The Banay boring was completed at a depth of 470 meters (1,542 feet) in the coal formation; the Raville boring —722 meters (2,369 feet) depth—went deep into the coal formation; and the boring at Lerquigny was not carried beyond the depth of 680 meters (2,231 feet), the coal stratum having been struck at the same depth as in the other bore holes, the geological features being the same. The carboniferous stratum dips under the younger formations in the direction of France and confirms a hypothesis that the Saarbrück coal measures extend toward Pont-á-Mousson. On the frontier it occurs deeper than 700 meters (2,297 feet) from the surface, but is certain to be struck at 900 meters (2,952 feet) or, at the most, 1,100 meters (3,609 feet).

Coal in Southern Russia.—While noting the German coal outlook, it would be well to observe what is being done at Riga (Russia). Its imports of coal, which were mainly from England and Westphalia, and which two years ago aggregated 33,000,000 poods (432,500 tons), have now decreased by about 12,000,000 poods (193,546 tons). By order of the government, coal is now derived exclusively from Russian mines. The local works and factories require about 20,000,000 to 30,000,000 poods (322,549 to 483,871 tons) of coal and 500,000 poods (8,065 tons) of coke per annum. Contracts are generally made in February and March for the period up to autumn and in August till spring. Petroleum residuals are rather expensive in Riga, and are only used experimentally on some locomotives on the local lines. Wood fuel is also unable to compete with coal, but is used on the small branch lines. Peat, although its deposits cover hundreds of square miles in the vicinity of Riga, finds no application whatever, because of its being comparatively expensive and inconvenient to handle.—O. J. D. Hughes, Consul General at Coburg.

Catalogues in Foreign Languages.—A report by the British vice-consul at Adana has been received at the British Foreign Office, from which the following extract has been made:

I am glad to say that I have recently received catalogues from British houses in the French language and the French comparative weights and measures, which is a step in the right direction. I would strongly advise our traders to send a card with name, address, and business before troubling to send expensive trade circulars and catalogues to consulates. In case a sale exists for such goods we shall not fail to reply. This will save much trouble, expense, and misapprehension, and will enable traders to form a good idea of what trade they can expect all over the world. By the present system no reply reaches them unless a definite question is asked, and, remaining in doubt, they continue to send catalogues, many of which must necessarily be of no use whatever in certain parts of the world.

Government Purchase of Railroad in Mexico.—Consul-General A. D. Barlow reports from Mexico City, June 6, 1903, that the Mexican government has purchased a controlling interest in the National Railroad —one of the two lines from that city to the frontier

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No. 1695, July 13.—*American Competition in South Africa—Mexican Linaloe—Trans-Siberian Railway Schedules—Changes in Venezuelan Import Duties—Preservation of Eggs—Losses of German Ocean Vessels—*American Typewriting and Salt-mining Machines Wanted.

No. 1696, July 14.—Butter Industry in the Argentine Republic—*The Osaka Exhibition—Mocha Coffee—An Electric Crane in Germany—*Catalogues in Foreign Languages.

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No. 1699, July 17.—New Controller of Boiler Water—New Railroad in Switzerland—*Reduction of Duty on Candles in Honduras—*Reopening of the Port of Mazatlan—*Demand for Pig Iron in Solingen—*Commercial Travelers in Roumania—*International Exposition at Milan in 1905.

No. 1700, July 18.—Portland Cement from Slag—*Sample Museums in Germany—*Print Goods in South Africa—New Rubber Plant—*German Export Prices for Iron—New Electric Fast-flashing Light—Rolling Stock of Russian Railways—*Effects of Dear Cotton in England.

The Reports marked with an asterisk (*) will be published in the SCIENTIFIC AMERICAN SUPPLEMENT. The other Reports can be obtained by applying to the Bureau of Trade Relations, Department of Commerce and Labor, Washington, D. C. Since the number of Reports is limited, application for those which are desired should be made immediately.

* 1 sole = 48.6 cents.

* Figures for the United States are for the fiscal years.

SELECTED FORMULÆ.

Whitewash.—

I.

Lime, clean and well burnt	6 quarts
Spanish whiting, or powdered burnt alum	4 ounces
White sugar	16 ounces
Rice flour	3 pints
Glue, of good quality	16 ounces
Water, boiling	5 gallons

Slake the lime in a vessel of about 10 gallons capacity, with hot water, keeping the vessel covered to retain the steam, and pass through a sieve to clear of coarse particles. Make up the rice flour to a thick paste and boil well, and dissolve the glue in water over a water bath; then mix the liquids with the remainder of the water, and add the whiting or alum and the sugar.

The mixture should be applied warm on outdoor surfaces, and cold indoors.

II.

Another formula said to be used by the United States government in making whitewash for lighthouses and some other public buildings, is as follows:

Unslaked lime	2 pecks
Common salt	1 peck
Rice flour	3 pounds
Spanish whiting	½ pound
Glue (clean and white)	1 pound
Water, a sufficient quantity.	

Slake the lime in a vessel of about 10 gallons capacity, roughly cover it, strain, and add the salt previously dissolved in warm water. Boil the rice flour in water; soak the glue in water and dissolve on a water bath, and add both, together with the whiting and five gallons of hot water to the mixture, stirring all well together.

Cover to protect from dirt, and let it stand for a few days, when it will be ready for use.

It is to be applied hot, and for that reason should be used from a kettle over a portable furnace.—Drug. Circ. and Chem. Gaz.

Bandoline.—

I.

Quince seed	2 drachms
Water	1 pint
Alcohol	1 ounce
Cologne water	1 ounce
Oil of cloves	6 drops

Gently boil the quince seed in the water until it is evaporated to 12 ounces, strain through muslin and when the mucilage is nearly cold add the alcohol, cologne and oil.

II.

Gum tragacanth	2 drachms
Water	8 ounces
Glycerin	1 ounce
Oil of rose	5 minims
Ammoniacal carmine solution, a sufficient quantity.	

Add the water to the tragacanth and when it has become soft add the glycerin and rose oil previously mixed, and color to suit. The perfume can be varied or the color omitted, according to fancy. Rose, almond, and orange are the odors usually preferred for bandolines.—Drug. Circ.

Lubricant for Glass Stop Cocks.—

I.

Pure rubber	14 parts
Spermaceti	5 parts
Petroleum	1 part

Melt the rubber in a covered vessel and then stir in the other ingredients. A little more petroleum will be required when the compound is for winter use.

II.

Pure rubber	7 parts
Yellow wax	3 parts

To keep the rubber mixtures in the best possible condition, they should not be exposed to air longer than necessary when heating, and they ought to be preserved in closed bottles. The stop cocks should occasionally be thoroughly cleaned and recoated with the rubber mixture.—Drug. Circ.

Cashmere Nosegay.—

Essence of violet, from pomade	1 pint
Essence of rose, from pomade	1½ pints
Tincture of benzoin (1 to 4)	½ pint
Tincture of civet (1 to 64)	¼ pint
Tincture of tonka (1 to 4)	¼ pint
Benzoic acid	½ ounce
Oil of patchouly	¼ ounce
Oil of sandal	½ ounce
Rose water	½ pint

—Drug. Circ. and Chem. Gaz.

Ink for Zinc Labels.—

Potassium chloride	60 parts
Copper sulphate	120 parts
Aniline blue	1 part
Diluted acetic acid	100 parts
Water	1,800 parts

Dissolve the potassium chloride and the copper sulphate in 1,400 parts of water; mix the acid in the remainder of the water and dissolve the blue in the mixture; then mix the two solutions.—Drug. Circ.

Dentifrice.—

Oil of peppermint, English	4 parts
Oil of aniseed	6 parts
Oil of clove	1 part
Oil of cinnamon	1 part
Saffron	1 part
Deodorized alcohol	350 parts
Water	300 parts

—Drug. Circ. and Chem. Gaz.

Pine-Forest Perfume.—

Oil of pinus picea	4 ounces
Oil of lavender	½ ounce
Oil of bergamot	½ ounce
Oil of lemon	½ ounce

—Drug. Circ. and Chem. Gaz.

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